THE

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ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS.

IT would be difficult for the most captious critic to find much fault with Mr. Epstein's paper read on the 11th inst. before the Institution of Electrical Engineers, and reproduced in our present issue. Neither in commission nor in omission is there aught to give offence; for what Mr. Epstein had to say was put forward with good taste and sense, nor could we doubt that he would have told us more if he had had more to tell. The observations made, and the data given, are generally accurate, if not novel, and are useful so far as they go.

We have ourselves every reason to endorse the statement that, until recently at least, all the experiments to utilise accumulators for traction on rails, although hailed with enthusiasm, have led to disappointment from a commercial point of view. In fact, this has been our contention, which is now endorsed by others; and we have equal reason to agree with the assertion that the success or failure of accumulator traction in the future will be decided by the merits of the accumulator, when these merits have been sufficiently extended and established. Moreover, we cordially agree with Mr. Epstein that the method of handling or mounting a given accumulator must affect to no inconsiderable extent the question of its successful application. But the system of stowing the cells of an accumulator in separate compartments beneath the seats of the tramcar—which system was illustrated in our issue of August 2nd, 1895—was out of date at that period; and we then described a plan of enclosing the accumulator in a case suspended beneath the car, which we think compares favourably with any other method suggested.

Mr. Epstein describes two systems of accumulator traction on rails, which may be referred to as the Hanover and the Paris systems. But the Hanover arrangements can scarcely be called a system of accumulator traction; they constitute a trolley system eked out by accumulators as an almost unavoidable necessity—the only alternative being a conduit system, the cost of which, under the existing conditions, was found to be prohibitive. To say that the "accumulator traction incurs an additional expense of ·4d. per car mile, as compared with the trolley," may be comparative praise when other results are considered; but it certainly does not indicate that accumulator traction is as yet commercially practicable where there is any possibility of utilising an overhead system. At Hanover, rightly or wrongly, the municipal authorities absolutely refused to allow the overhead conductor in the city itself. In consequence of this decision, about 10½ miles of track, to be worked by accumulators, had been laid at the commencement of the present year; the trolley system being at work over nearly 13 miles. The accumulators are carried over the whole distance, and are charged *en route*. It may possibly be an improvement, as is suggested in the paper, to place the accumulators "in a

C

frame slung to the car, or in dummy cars, either of which could be picked up at the end of the trolley section; while the charging could still be effected in the same manner from the trolley wires." But, on the other hand, it is questionable whether this plan would not neutralise one of the advantages which have been claimed for the mixed system of traction, viz., the action of the accumulators as "equalising batteries," greatly reducing the variations of the load upon the machines at the central station. It was interesting to hear from Mr. Epstein that at Hanover "the running expenses of the electrical system, including driver, amounted to 2·22d. per car mile;" but this figure has to be supplemented by other commercial data before the paying capacity of the line, worked on the mixed systems, can be arrived at.

Turning now to the "Paris system," where the plan has been adopted of charging the accumulators at the stopping places, we are told that the Société des Moteurs are working a 12-mile line at the same cost, including depreciation, as horse traction. From a pulmonary, ammoniacal and general cleanliness point of view, the substitution of electric traction for the latter in a crowded city is no doubt a blessing; but it is no great commendation of the new system to state vaguely that it is being worked, for a period of time which may be limited to the present, at the same cost as horse traction. The cost of horse traction varies with the locality and other conditions, and the present cost of horse traction in Paris is to most, if not to all of our readers, as it is to us, an unknown quantity. In London, it has been stated, it may be as high as 1d. per ton mile. But according to the figures of M. Jules Sarcia, which have often been referred to in these columns, the cost of accumulator traction in Paris, including labour, maintenance, and handling of batteries, and wear of trucks and motors, should not be higher than about ·37d. per ton mile. This estimate was arrived at from returns extending over a considerable period—from 1892 to the end of 1894, and was embodied in a report of the Conseil d'Administration of the Société des Tramways.

It is only indirectly that we can arrive at the weight of accumulator, per ton mile, which Mr. Epstein would consider necessary, under present conditions, on tram lines. And here we have occasion to protest against the use of the "car mile," or "car kilometre," as a unit in cases where a datum value is involved, *e.g.*, when we are told that the running expenses of the electrical system at Hanover amount to 2·22d. per car mile. Taking this as a datum, we have to compare it with the cost of the car mile in other cases. But the comparison would be futile and misleading; for the car mile—a value which may be useful enough in the account books of a tramway company—is not a definite unit, but varies with the weight of the car and of its load. And the weight of a car may have any value between or outside of 8½ tons—the weight of the (1890) Madeleine-Levallois Perret car—and 14½ tons—the weight of the Madeleine-St. Denis (1896) car, with its passengers. If Mr. Epstein had mentioned the *weight* of the Hanover car, we might have calculated the cost of the ton mile, which, under given conditions, may be taken as a unit of work, and allows of comparisons which—although possibly they might be "odious"—would not be altogether illusory. But it cannot be by reason of the indefiniteness of the unit employed that so great a discrepancy exists between the estimate of Herr F. Ross—who, we have understood, has given the cost of the car mile, on the electrical tramline at Hanover, as being less than 1d.—and Mr. Epstein's estimate as above.

Mr. Epstein's ideal cell for traction purposes is not exactly what we look forward to. We quite agree that such a cell must be able to withstand jolting without shedding, and high discharge rates without buckling, and that, moreover, it must not decrease in capacity while in use; but our ideal cell is very much lighter than anything Mr. Epstein has in view. No positive plate will, in fact, come up to our ideal until local action between the active material and its support has been so far obviated or reduced as to allow of this support being of no greater weight than that requisite for conduction, whilst at the same time its permanency is greatly increased. These may be hard conditions, but we believe that they are attainable. In regard to the negative element, there appear to be no great difficulties to overcome; but we do not agree with Mr. Epstein that a reduced Planté positive is the best that can be provided. The positive element tends always to increase in capacity; the proposed negative, initially of comparatively low capacity, would tend always to decrease in this direction. It seems obviously desirable—as indeed Mr. Epstein himself elsewhere points out—that the capacity of the negative element should initially be considerably greater than that of the positive element; so that at no time it should fall below it.

In conclusion, we must congratulate Mr. Epstein for having directed attention to matters which at the present moment require discussion, and are of considerable interest and importance.

The Application of Electric Power on Trunk Line Railways.

In commencing an article with the above title in the *Engineering Magazine*, Prof. George Forbes endeavours to disarm criticism, by stating it not to be his purpose to instruct engineers in the duties of their profession, or to suggest to manufacturers any new direction in which to work, but to give to those financially interested the results of careful study and extensive calculation. To this end he gives a few figures relative to existing lines, and condemns the use of steam power at one end of the Niagara Falls Park and River Railway. Here at a distance of only 12 miles from the Falls a steam plant is installed, whereas a high tension current transformed down for use might have been far more cheaply employed. The author considers there has been an absurd hesitation in carrying out long distance transmission. Scotland is instanced as a country which could easily develop so much electricity by water power as to drive all its railways were the companies concerned to unite for the purpose of doing so. The writer gives the train mile cost of the South London line, the Overhead Liverpool, and the Metropolitan as 6·48d., 3·84d., and 11·76d., the relative weights being about 37½, 38¼, and 157½ tons. In advocating trunk line working by electricity, the writer would use current at 10,000 volts on the feeders. This might be continuous, but would be more manageable if alternating, and should be reduced by commutating machines. But these as first introduced by Mr. Schuckert are, though admirable workers, expensive and cumbrous, and require continuous attention. Not so the new design prepared by the writer, which will abolish all these faults, and it is only a question of time for manufacturers to find it to their advantage to take it up. The writer also believes in the application of power to every axle in preference to the use of separate locomotives, but if anything is to be done with the trunk lines, locomotives on the separate plan will be necessary, but will prove much less advantageous than the method of live axles. The Professor also looks forward to the early use of electricity on all London underground lines, and considers that the difficulties due to the change from steam

to electricity for such trains as run out into the country have been much exaggerated, and there is really nothing to prevent the immediate introduction of electricity on London's underground system. For desert railways, such as that from Wady Halfa across the desert, electricity is the proper motive power. Thus no water was to be had for the 230 miles to Abu Ahmed, and for every train carrying rails and sleepers beyond 150 miles there were required three or four trains to carry water and coal. The writer makes light of the superior facilities of door-to-door travelling afforded in America by the electric roads in competition with the steam railroads. The door-to-door idea can only fit people along the road. What is wanted on the existing lines is electric working and a more free communication of the trunk line stopping places with the local street railways. A good deal might be retained to existing lines by more frequent service which electrical working would afford.

The Engineering Dispute.

On the general question of the dispute, *Cassier's Magazine* contains two articles, one by Col. Dyer and another by Mr. Benjamin Taylor. The Colonel shows in the first place how it came to pass that Mr. Barnes secured the post of general secretary to the A.S.E. by a compact with Mr. Tom Mann, who engaged to withdraw his candidature for a price, *viz.*, Mr. Barnes' adherence to the eight hours' demand. Thus the A.S.E. were simply sold between the selfish ambitions of two mischievous talkers, and being sold, they have in due course been crucified. We learn, however, as we go to press that this has since been denied by Mr. Barnes, and his refutation frankly accepted by Colonel Dyer. The first step taken by the new secretary was to demand that all machines should be put into the hands of the A.S.E., or paid for at top prices; machines were to be rated, not men. There was a conference at which many concessions were made. Then a demand for 48 hours was made and entire control of machinery, and this caused the growth of the Masters' Federation, which had hitherto been small, and to crush which the A.S.E. had striven with every artifice in its power. In regard to the claim that the nine hours' day did not stop the growth of English trade, it is shown that, as compared with other countries, the relative increase was very seriously checked after the date of the introduction of nine hours in 1872. A few facts in foreign competition next follow, such as the delivery in Calcutta of rails from Pittsburgh, and Mr. Barnes's claim is quoted, that the A.S.E. fund of £350,000 was quite sufficient to dislocate the trade of the country, as though trade could be dislocated with benefit to anyone. The legal right to spend provident funds is touched upon, for Col. Dyer looks on the power to do this as certain to smash the unions from within. The liberty of the subject as threatened by the unions is referred to, for trade union law has ousted English law, as witness the weak bench of the country when a question of rattening comes up, even when of the most vicious nature. Why has no perpetrator of any outrage ever been called to account by any trade union, unless the leaders really do countenance such outrage? The article is accompanied by a number of letters from engineering firms bearing upon the question of interference. Mr. Taylor shows in his contribution something of the methods of the shop stewards, the spies of the A.S.E. in all the workshops they can get into upon the shop methods generally. These stewards are the men who report to head-quarters all items on which an employer can be harassed. Mr. Taylor details the history of the machine dispute at Messrs. Earles, of Hull, at the Sunderland Forge and Engineering Company, and at Elswick, both of which latter were probably fomented by the so-called Hull settlement by the Board of Trade, and many doubt very much the wisdom of the Board of Trade's present interference. The time has arrived, in fact, to end or mend engineering in Britain, and one of these will follow the masters' defeat while the other will accompany a thorough defeat of the men. The present uncertainty must end at all costs. Mr. Taylor shows, as we have tried to show, that the demand for skilled workmen must inevitably follow upon the liberty to run machines to best advantage, and no employer is likely to run a valuable machine tool at less wages if he can get more work out of it with a dearer man. The contention of the A.S.E. is simply that a lawn mower must not be run by a gardener. This looks silly, but it puts the case in a nutshell. At Elswick, men known as feed and speed men have to be employed to see that machine tools are not kept at low outputs. This is simply a tax on industry. It reduces these men from producers to non-producers. A table is added showing the rise of wages since 1891, and there is also a considerable amount of other information, some of the facts being, however, rather a duplication of the previous article.

Hints for Investors.

A writer in the *Financial Times* has been considering electric lighting companies securities from the investor's point of view, and the conclusions set forth are interesting, if only to show how easily the guardians of finance are apt to fall into error on matters a little outside their ordinary business. We all recognise the infallibility of financial writers on gold mines, railways and breweries, but we cannot always admire their methods of dealing with electrical affairs. There is, however, some satisfaction to be derived from the opinion of the *Financial Times* correspondent that "the commodity (by which is meant electrical energy) produced by all the companies, is of exactly the same quality—a statement that cannot be made in regard to any other industry." There is undoubtedly very little room for adulteration in an electric supply business, unless you take to watering the capital, but though there may be lack of opportunity he would be a bold man who declared that all electric lighting systems gave equal satisfaction to their respective consumers. This is by no means the only instance in which the writer arrives at original and highly diverting conclusions.

By their Capital per Kilowatt ye shall know Them.

After further advice to investors, the correspondent of the *Financial Times*, who, by the way, exhibits a striking predilection for the County of London and South London Electrical Companies, suggests that the governing element from an investor's point of view is the capital per kilowatt. Bearing this in mind, the writer proceeds to build up an interesting table, showing the approximate amount of capital per kilowatt of the principal London companies, which is as follows:—

Company.	Approximate amount of capital per kilowatt.
	£
St. James's and Pall Mall	88
South London	88
House-to-House	100
Kensington and Knightsbridge	123
County of London	125
Westminster	127
Chelsea	163
Charing Cross and Strand...	172
Metropolitan	190
City of London	195
Notting Hill	227

The logic of this table is that the South London and House-to-House Companies are among the best investments, while the Metropolitan and City of London are among the worst. We should have thought that the dividends paid would have had considerable weight with investors, and if we take the into consideration, we are able to make a rectification of this table by showing the last distribution of profits on the ordinary shares.

Company.	Approx. amount of capital per kilowatt.	Last div. paid on ordinary shares.
	£	%
St. James's and Pall Mall	88	10½
South London	88	...
House-to-House	100	nil
Kensington and Knightsbridge ...	123	7
County of London	125	...
Westminster	127	9
Chelsea	163	5
Charing Cross and Strand	172	6
Metropolitan	190	5
City of London	195	7
Notting Hill	227	4

It is not necessary to say more to show the utter fallacy of estimating the value of a company's position by the capital price per kilowatt. The question of land, buildings, and the fact that the plant may be too large for the existing demand are factors that cannot be lost sight of.

AN ELECTRIC CURVE TRACER.

For Delineating the Forms and Phases of Periodic Electric Quantities, viz., Electric Currents, Electromotive Forces, Electric Power, and Magnetic Induction: also for Tracing Hysteresis Curves.*

By Prof. EDWARD B. ROSA, Ph.D.

Undoubtedly one of the most interesting and fruitful methods of study and investigation of alternating current phenomena is the tracing of the forms and phases of alternating current waves. Without these curves one can gain only a very inadequate idea of the inner workings of a dynamo, motor, or transformer; and, considering the rapid multiplication of alternating current apparatus, both of single-phase and multiphase varieties, it is evident that the field of usefulness of alternating current diagrams, already very great, is constantly increasing.

The practicability of this method of investigation and testing has been seriously limited by the great labour of obtaining the curves, and the insufficient accuracy of the curves when obtained. To find and plot a dozen or two points and then draw a smooth curve through them, and call it the curve of current or electromotive force will sometimes answer, for want of something better. But it is often unsafe to infer very much from such a curve. What is wanted is so large a number of points as to be practically equivalent to a continuous line, marking exactly the fluctuations of the current. And when several such related curves have been drawn to scale on a single sheet, showing the forms, phases, and relative amplitudes of the currents and electromotive forces (and, perhaps, also the magnetisations and power waves) which are concerned in the operation of a given machine or system, we have a beautiful picture of what in algebraic language merely is not very attractive.

Various methods of obtaining these curves have been employed. An instantaneous contact maker, connected with the armature of the dynamo, is generally used. The disc of the contact maker revolves with the same angular speed as the dynamo, and a brush which rests upon its edge makes contact once in every revolution with a knife edge let into the disc. As the brush is advanced step by step, contact is made at later instants in the phase; but while the brush is at rest in any position, the current and electromotive force return to the same values at each successive instant of contact. The value of current at the instant of contact (fig. 1) is determined by measuring the difference of potential of the terminals, A B, of a known resistance through which the current flows. This potential difference is sometimes ascertained by joining a condenser, C (fig. 1), to A B,

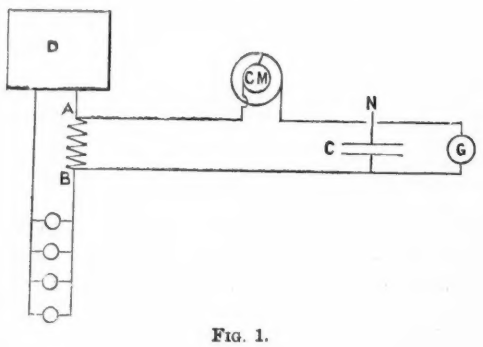


Fig. 1.

by a switch, N, through the contact maker, M, and then discharging the condenser through a ballistic galvanometer. Under these circumstances, the charge of the condenser will be proportional to the difference of potential between A and B at the instants of contact in M, and this in turn is proportional to the corresponding instantaneous value of the current flowing from the dynamo. The position of the contact brush is then advanced, the condenser is again charged and discharged, and a second value of the current, corresponding to the new phase of contact, is obtained; or an electrometer may be substituted for the galvanometer, and its deflection read at each setting of the brush. In this way a number of points may be obtained and plotted out on cross section paper, and a curve drawn through them. But if the number of points is sufficient to give an accurate curve, the time and labour required are very great. Moreover, it may be impossible to keep the circumstances of the circuit constant for so long a time, and the later ones of a set of curves will not, therefore, correspond with the first.

The Potentiometer Method.

In the following potentiometer method readings can be taken more rapidly, as well as more accurately, than by using a ballistic galvanometer or electrometer. A hard rubber rod, anywhere from 60 to 100 centimetres in length, is wound with one layer of copper or German silver wire. If the wire is bare, the rod may be threaded in a lathe, and this will secure insulation and uniformity of winding; if insulated, the insulation may be removed along the top side, so that a sliding contact piece passing over it will always make good contact (fig. 2). A current from two or three storage

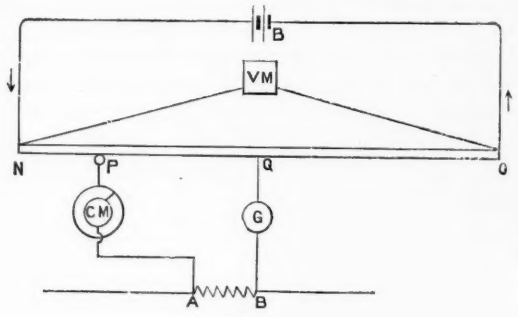


Fig. 2.

cells flows through this potentiometer coil, and by means of a voltmeter and adjustable resistance, the difference of potential of the ends of the coil is maintained constant. The instantaneous difference of potential at the terminals of A B is now measured by matching it against the known difference of potential of a part of the coil, N O. The point, Q, at the middle of N O is joined through a galvanometer to B, while P, a sliding contact, is joined through the revolving contact maker, M, to the point, A. When the difference of potential at A B and P Q are equal, there is no deflection of the galvanometer. P is therefore moved in the direction indicated by the galvanometer deflection, until the latter is reduced to zero. The distance, P Q, is then proportional to the current through A B, and knowing the difference of potential, P O, and the resistance, A B, we determine at once the precise value of the current. The brush of the contact maker may then be advanced, when the new setting of P will give the new instantaneous value of the current through A B. The galvanometer should be dead beat, quick, and fairly sensitive. A d'Arsonval meets the conditions admirably, and indicating, as it does, the direction in which P must be moved to secure a balance, is superior to a telephone, which could be used. When the current is flowing from A to B, A will be at the higher potential, and P will fall somewhere on the left of Q. If, however, the current is from B to A, then P is on the right of Q. If the potentiometer coil is uniformly wound, and the settings of the sliding contact carefully made, this method gives very accurate results, and with less labour than most step by step methods. But at the best it is slow and laborious. If one undertakes to determine a large number of curves, the successive settings of the brush are very tedious. The scale readings of the contact, P, must all be taken and recorded, and finally after these readings have been reduced, the curve is plotted out carefully by hand. One does this very willingly for a while, but if one attempts to determine accurately a considerable number of curves the work becomes a burden.

An Automatic Instrument.

It was while engaged in this kind of work nearly two years ago that I undertook to devise an apparatus that should reduce the labour and increase the speed of drawing

* This electric curve tracer formed the subject of a communication by Prof. Rosa to the British Association.

electric curves. The apparatus which is shown in figs. 3 and 4 is the outcome of this endeavour. The most laborious parts of the operation, including setting the contact brush, are done automatically by the machine, and the work of several hours may be done in as many minutes. The measurements are made by the foregoing potentiometer method, the results are simultaneously plotted by the machine more accurately than they could be plotted by hand, and a curve being obtained in a few minutes, the speed, voltage, and other circumstances may be maintained more nearly constant than would be possible when the observations extend over several hours. For these reasons the curves obtained are of unprecedented accuracy.

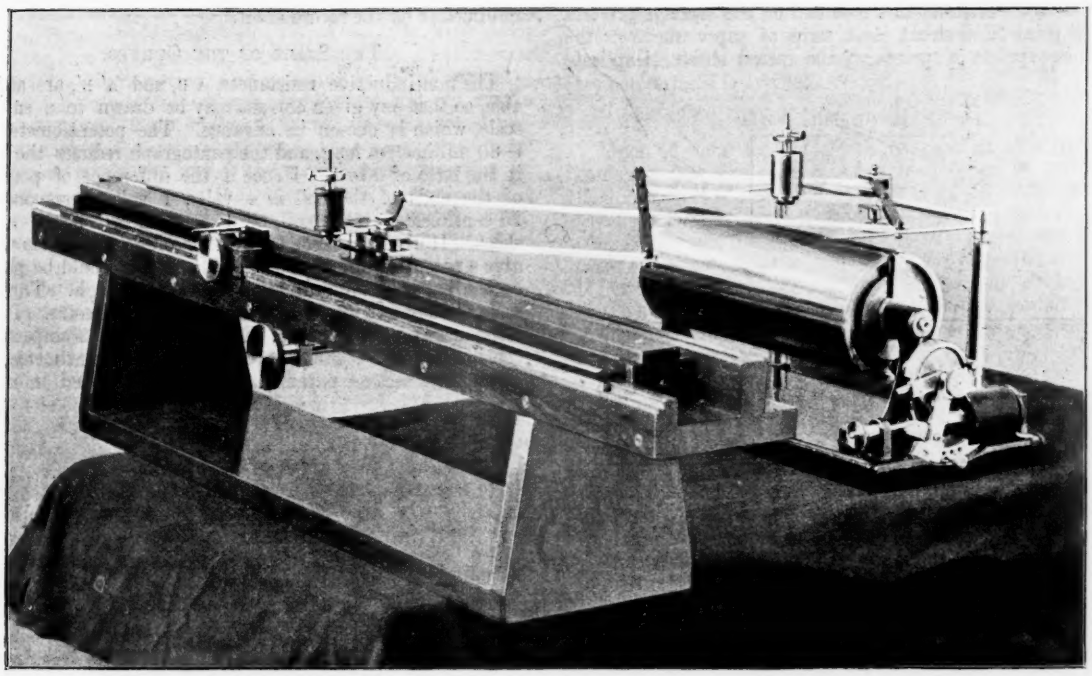


Fig. 3.

(Fig. 5). To avoid the labour of reading, recording, reducing, and plotting the various values of the current and electromotive force, a pantagraph is employed to print the curves automatically as the settings are made. The pantagraph has one end fixed at P′ and the other end fixed to the carriage to which is attached the movable contact, P. On an extra bar the printing electromagnet, F, is carried, and as the carriage and sliding contact, P, move to and fro along the spiral, F moves to and fro in a parallel line at a reduced speed. The distance of F from its zero position is therefore always proportional to P Q, that is to the value of the current at the instants of contact. Hence by printing a point directly under F upon a sheet of paper carried by a cylinder or plate, the instantaneous value of the current is permanently registered. This is done by closing a key, when an electric current passes through F, and throws a steel point down upon a typewriter ribbon, printing a dot on the paper beneath it. This current also passes through an electro-magnet on the contact maker, and another on the record cylinder, attracting their armatures against the stop pins (see figs. 3 and 4). When the key is released and the current broken, these armatures are drawn back into their former positions by springs, and at the same time a pawl on each engages a ratchet wheel and advances it one or more teeth, according to the position of its stop pin. Thus, closing the circuit, prints a point upon a sheet of cross section paper which permanently records the value of the current. Breaking the circuit an instant later causes the brush and cylinder to advance ready for a new setting of P and another point on the paper.

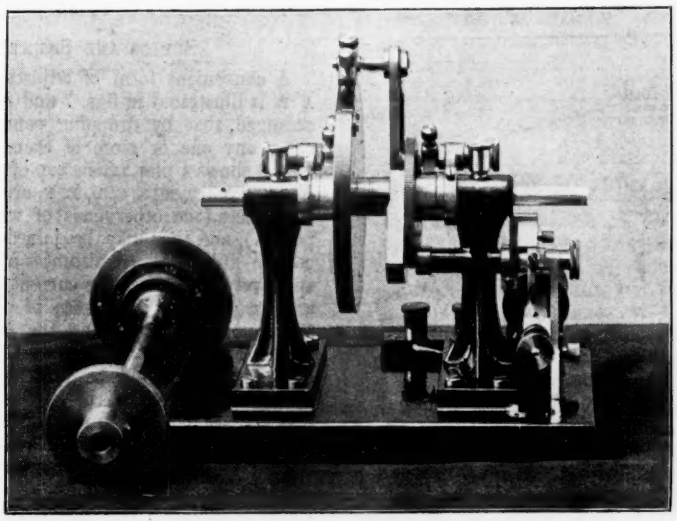


Fig. 4.

Drawing the Curves.

The galvanometer used is a quick, dead beat d'Arsonval, and settings are made very rapidly. The carriage, to which the sliding contact and pantagraph are attached, is moved to and fro by a cord which passes over pulleys at the ends, and is wound over a drum underneath the potentiometer coil. This drum is turned by a milled head, shown in the photograph. The observer keeps his eye fixed upon the galvanometer scale. With his left hand he turns the milled head, and so adjusts the sliding contact; with his right he works the contact key. As soon as the latter is opened the

brush advances, and the spot of light on the scale goes off the zero, to the right or left, according as the current has decreased or increased. The contact, P, is immediately moved in the same direction until the spot of light is brought back to zero, when the circuit is again closed, a point is printed, the brush advances, the spot of light again goes off the zero, &c. Twenty points a minute can be printed after some practice.

A second electro-magnet mounted on the carriage prints a pencil point (if desired) on a strip of paper whenever the first one prints a point on the record sheet. Duplicate

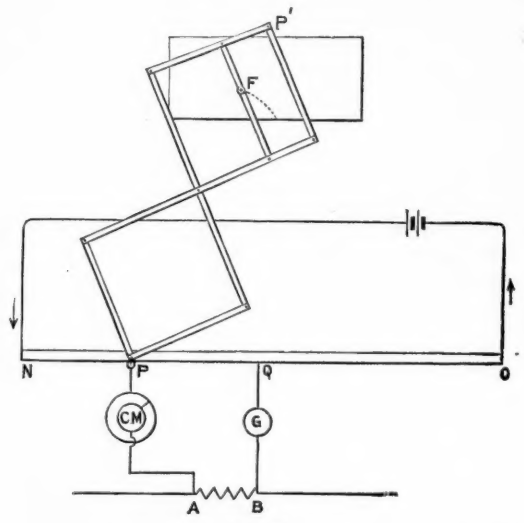


Fig. 5.

curves can then be printed by setting the pencil point over these dots, without running the dynamo, and curves originally printed on separate sheets can be combined on the same sheet. Typewriter ribbons of different colours are used for different curves, so that the curves are easily distinguished, even though they be considerably interlaced. The teeth of the two ratchet wheels are numbered, so that the contact brush and record cylinder can be set at any particular position desired. In drawing a curve their initial positions are noted (fig. 6), and when the curve is finished (suppose it

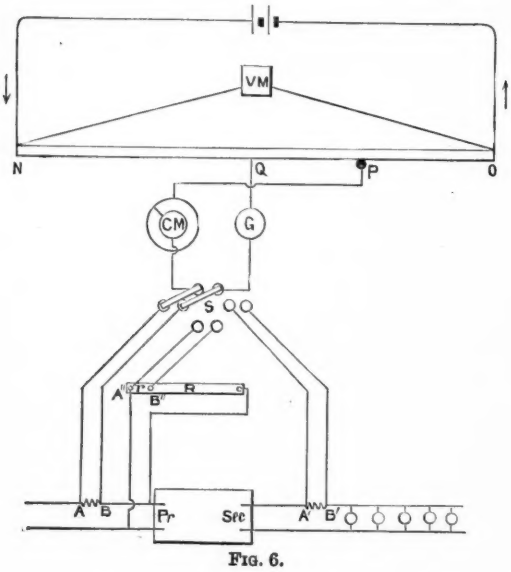
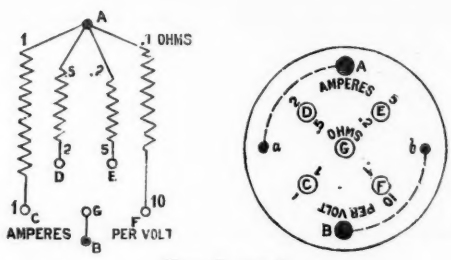


Fig. 6.

represents the electromotive force of a dynamo), the brush and cylinder are turned back to the initial position, the switch, S, thrown so as to connect to the points, A, B, of the primary circuit of the transformer, and the primary current is drawn. Turning back again to the initial position, and joining to A', B', of the secondary circuit, the secondary current is drawn. The difference of phase of these waves will then be accurately represented by their distance apart on the record sheet. The cylinder is 360 millimetres in circumference, and two complete wave lengths extend once around it. One wave is, therefore, 180 millimetres long on the record sheet, and 1 millimetre is 2°. Hence differences of phase are easily determined by counting the distance in millimetres on the record sheet.

The Scale of the Curves.

The non-inductive resistances, A B, and A' B', are adjustable, so that any given current may be drawn to a suitable scale, which is chosen in advance. The potentiometer coil is 80 millimetres long, and the pantograph reduces the scale in the ratio of 5 to 1. Hence if the difference of potential of the ends of the coil is 4 volts, 1 volt corresponds to 20 centimetres on the coil, or 4 centimetres on the record sheet. If the resistance of A B is $\frac{1}{4}$ ohm, 4 amperes would give a potential difference of 1 volt, and this would be plotted on the paper as an ordinate 4 centimetres high. Thus the scale of the curve would be 1 ampere per centimetre. If the resistance of A B is $\frac{1}{8}$th ohm, the scale would be 2 amperes per centimetre; if $\frac{1}{40}$th ohm, 10 amperes per centimetre, &c. If the cross section paper is (figs. 7 and 8) ruled in inches



Figs. 7 and 8.

and tenths or twentieths, as is the case with what I have generally used, the scale works out similarly: 80 centimetres equal 31·5 inches; one-fifth of this is 6·3 inches, the extreme range on the paper. Let the difference of potential of the ends of the potentiometer coil be maintained at 6·3 volts. Then 1 volt on the coil corresponds to 1 inch on the paper. If A B has a resistance of $\frac{1}{4}$th ohm, the scale of the curve is 4 amperes per inch; if $\frac{1}{8}$th ohm, 8 amperes per inch; if $\frac{1}{40}$th ohm, 40 amperes per inch, &c.

Series and Shunt Resistances.

A convenient form of adjustable resistance for A B and A' B' is illustrated in figs. 7 and 8. Four resistances are so arranged, that by dropping connecting links into mercury cups, any one or more of them may be used in parallel. Fig. 8 shows a plan of the top of one of the resistance boxes. Four mercury cups, C, D, E, F, are the terminals of the four resistances (the other ends of which unite at the binding post, A), and they may be joined to the central cup, G, by copper links. The resistances are 1, $\frac{1}{2}$, $\frac{1}{5}$th, $\frac{1}{10}$th ohm respectively, and hence the current would be 1, 2, 5 and 10 amperes per volt difference of potential of the terminals, these numbers expressing the conductance of the several coils. From what has been said, it is evident that the scale of the curves would be 1, 2, 5 or 10 *amperes per inch*, according to which of the four resistances was used. If the first and second were used together, the scale would be 3 amperes per inch; if the first and third, 6 amperes per inch; if all were used at once, 18 amperes per inch. For heavier currents smaller resistances of greater carrying capacity would be used. The small binding posts, *a b*, are connected with the large posts, A B, as indicated, and from them wires pass off to the switch, S, of the fig. 6. The resistance of A B may be altered so as to have the current drawn to a suitable scale without breaking the circuit, and the scale is read off directly without any other numerical calculations than adding the conductances, as already indicated.

If the non-inductive resistance, R, is 2,000 ohms, and *r*, a part of it, is 20 ohms, that is $\frac{1}{100}$th of the total, then since the difference of potential of A'' B'' is drawn out on the

second sheet on a scale of 1 volt per inch, the scale of the electromotive force curve will be 100 volts per inch. If A″ B″ is 10 ohms, then the scale of the curve is 200 volts per inch, &c. In a similar manner power curves, magnetic induction curves, and hysteresis curves are drawn to a known scale.

Derived Curves.

Magnetic induction curves are not drawn directly, but are derived from the electromotive force curves. Writing down from the curve the instantaneous values of the electromotive force for a single period, and summing them up, we get a series of values of the induction which are laid off upon a strip of paper. This is placed upon the curve tracer precisely as when duplicating curves, and the curve of magnetic induction is printed upon the record sheet, showing its proper phase relation to the other curves. Its position is determined by the consideration that the induction is stationary, usually a maximum, when the electromotive force is zero.

Hysteresis curves are derived from the curves of current and magnetic induction already drawn, and include the eddy current loss with the hysteresis loss. The current which has magnetised the iron under investigation is printed on a narrow strip of paper and attached to the end of the record cylinder at right angles to its position when printed. Two persons are required. One sets the pointer attached to the carriage upon the first point of the strip of the induction curve, while the other observer, taking the ratchet wheel in his left hand, sets the cylinder so that the first point of the current curve comes directly under a fixed line above the cylinder. A point is then printed on the record sheet, when the two observers advance to the second points, print a second dot, &c.

Power Curves.

Power curves, like curves of current and electromotive forces, are drawn directly while the generator is running. A second solenoidal coil, 80 centimetres in length, is mounted in the instrument parallel with the first. It has a sliding contact propelled by a rack and pinion, shown in the figure. This second coil is of German silver wire, and is in series with a larger non-inductive resistance, R; it carries a current proportional to the electromotive force, the terminals, T T′, being joined to the dynamo, or to the terminals of the circuit to which the power curve is to be drawn (fig. 9).

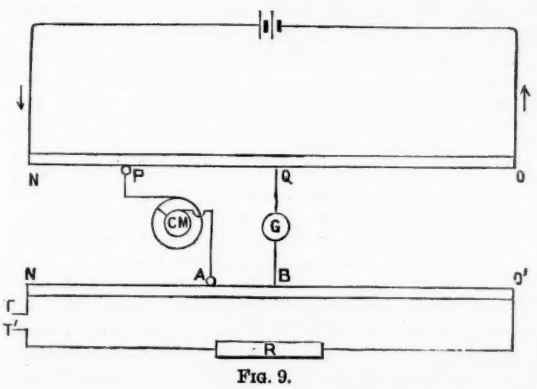


Fig. 9.

Instead of using a fixed resistance, A B, as in other cases, the resistance whose terminals are A B is varied, being in each case proportional to the current at the instant of contact. This is effected by having B fixed at the middle of N′ O′, and then setting A by the points printed by the extra electromagnet on the strip of paper when the current curve was drawn. When the current is negative, A is on the right-hand side of B. The difference of potential between A B is proportional to the distance, A B, and also to the current passing through the coil, N′ O′. Since the former is proportional to i (the current) and the latter is proportional to e (the electromotive force), the difference of potential of A B (and therefore of P Q) is clearly proportional to the product, which is the instantaneous power. Advancing the contact brush gives contact at a later instant of phase, when both i and e have changed. Setting the contact, A, to the new value of the current, and moving P until a new balance is obtained, a second point of the power curve is obtained. Obviously the power curve will cut the zero line whenever the current is zero (for then A comes to B), and also whenever the electromotive force is zero (for then there is no current in N′ O′). It has a positive loop when current and electromotive force are both positive or negative, and a negative loop when only one is positive. Thus are power curves accurately drawn to a predetermined scale, and the labour of multiplying the corresponding ordinates of current and electromotive force is avoided.

The Contact Maker.

Much of the success of the curve tracer depends upon the contact maker, and great care has been taken in perfecting it. The shaft of the contact maker is joined to the shaft of the dynamo (or, perhaps, to a synchronous motor), by a coupling shown in the figure. At the nearer end of the connecting rod the latter is joined to the plate (which latter is fastened rigidly to the shaft by a collar and set screw, as shown), by a flexible steel diaphragm, so that perfect alignment of the contact maker and dynamo is not necessary. At the further end the plate carries two steel pins, one at its centre and one near its edge, which fit loosely into two corresponding holes in a plate clamped to the end of the dynamo shaft. Thus the end play of the armature is not communicated to the contact maker, and when the latter is clamped to a firm base, the shaking and jarring of the dynamo are not transmitted to the contact maker. Two oil cups carry a good supply of oil, and the shaft carrying the hard rubber disc runs as smoothly as a top, hour after hour if desired, with very little attention.

The galvanometer current, which flows momentarily when the knife edge in the hard rubber disc passes under the contact brush, enters at the binding post, which is seen behind the left-hand oil cup, passes through a brush to a slip ring on the left of a large disc, and from there to a steel knife edge or contact piece let into the edge of the hard rubber disc. Passing to the brush and insulated brush holder, the current flows to a second slip ring, and away by a second brush and binding post on the right. The mechanism which advances the brush can be understood by comparing figs. 3 and 4. The teeth of the ratchet and large gear are numbered, so that the initial position of the brush can be recorded, and the brush returned to the same position for the beginning of successive curves. The milled head on the end of the spindle which carries the ratchet wheel and pinion enables one to set the brush quickly by hand at any desired place. The two binding posts seen at the back of the base are the terminals of the coil of the electro-magnet which operates the ratchet.

ELECTRIC TRAMCAR CONTROL.

In a paper read lately before the Chicago Electrical Association, Mr. J. R. Cravath—while admitting that the item of motive power is usually but a small part of the operating expense on electric tramways—claims the attention of engineers and managers to what has been hitherto a somewhat neglected source of waste, *i.e.*, the improper handling of car controllers by motor men.

Without doubt this matter of speed control and economical use of current, both at starting and in running, is one of the small items that make a considerable difference to the entire output when properly regarded, and Mr. Cravath's paper is, therefore, well worthy of reference in that respect alone. He shows very clearly, however, in addition, that the secondary effects of strict economy in current control are also of great importance, and this will be manifest if the chief items of possible waste are noted.

First, of course, amongst these is the loss of energy due to the motor man endeavouring to accelerate his car too quickly. This means a heavy starting current, with consequently a heavy demand upon the power house plant, with greater losses in the circuit generally. It has been suggested that the use of a speed indicator upon the car would help very

materially to enable a motor man to make good starts, the controller handle being moved round in accordance with the speed attained, so that the contact would not be on too high a notch at any time.

Then again, there is the question of loss of energy due to slip of the wheels at starting—which may be caused by the motor man attempting to attain a high speed almost at once; and thirdly, comes the waste of current due to running at a high notch until the very last moment before putting on the brakes. With care and attention every good motor man—whether running on fixed stops or not—can very often, if not actually in all cases, save a considerable amount of current by cutting it off at the earliest possible moment and allowing the car to drift along, the brake being only used for the final pull up.

Obviously, a saving of current in any of these directions must make a great difference to the calls upon power house plants, feeders, &c., besides which the repairs to motors will be greatly reduced. In regard to these points, Mr. Cravath states that on one electric tramway system in Chicago (where means were adopted for checking waste of current at starting by means of a special appliance on each car) not only was there a saving of 15 per cent. effected in the coal consumption, but the maximum load at the power house was reduced by at least 25 per cent.

Tests of excessively rapid acceleration are also noted—in one series the controller was put to the top notch in four seconds, and speed was attained in 9½ seconds. In another series 10 seconds were taken for moving round the controller to top notch, and speed was attained in 12 seconds from the start. The watt-second consumption in the latter case was about two-thirds that in the former: the maximum drop in voltage being respectively 80 in the rapid acceleration test, and 20 in the slow.

The same results appear to have been attained on other roads employing a heavy high speed service, but as the controllers here were of the plain rheostatic type, the figures need not be given.

Mr. Cravath recommends that every motor man in starting a car should pause after each notch long enough to let the car run nearly up to speed on that notch; that is, he does not need to wait until no further increase of speed can be detected, but should do so at least until he feels that the motors have responded to the controller movement. Special care is needed when passing over from series to parallel working, and upon a field shunt point.

All this, and more of it which we cannot quote or deal with here, is very good advice, and worth digesting by all tramway men.

DISTRIBUTION OF ELECTRICAL ENERGY.

By RANKIN KENNEDY.

Mr. Wordingham's paper on this subject is of more than passing interest in several ways, it is the expression of the opinions and experience of one actually engaged in the business of distribution; it reverts to the old question alternating *versus* continuous currents for the purposes of transmission and distribution at a very opportune time, as it is now about ten years since the two rival systems commenced competition.

Ten years is long enough experience to conclusively prove the superiority of one or the other, at any rate it is long enough to show clearly to the trained engineer in what cases and circumstances one or other may be adopted with most advantages.

At the outset of the electric lighting movement among municipalities, electrical engineers were divided on the question of systems, and it became known at once what system would be adopted immediately the advising engineer's became known. But there has been too much of this blind persistence in one system regardless of circumstances.

The engineer who goes on from year to year advocating the use of one system under all conditions has much to learn, and ought to be avoided by those requiring guidance.

It was high time some one in the business of electrical distribution took up the question openly and boldly, for hitherto those committee men and councillors who have been called upon to appoint electrical advisers, have had little or nothing to guide them to a selection of a system, yet if they appointed A they were in for continuous currents; if B secured the appointment alternating currents were prescribed, the nature or conditions of the supply notwithstanding.

Mr. Wordingham takes up the question fairly and squarely, and his arguments, illustrations and facts, should serve as considerable aids to gentlemen who are responsible for the adoption and establishment of electrical distribution systems. While properly comparing the two systems he, without any show of partisan spirit, beyond all doubt proves the superiority of the continuous current methods.

The only advantage that ever could be claimed in favour of alternating systems was the saving of copper in the distributing mains, but shortly after it came into general use it became quite evident that only in rare cases could any such savings be effected. It soon became necessary to add transmission mains to sub-stations, using transformers of large size, so that at present some towns have nearly as much low pressure alternating distribution mains as others using continuous current, with all the additional cost of sub-stations and high pressure mains thrown in extra; the saving claimed for the alternating systems have thus been more than wiped out in the majority of towns where it has been adopted.

The Deptford system may be a success or not, but it has the merit of being rational, it was designed to supply electricity to the largest city in the world from one huge power house situated miles away from consumers, the situation being specially chosen for the cheap delivery of fuel, water, and supplies of material. No other system was possible to carry out the scheme, and even had it succeeded in lighting up all London from one centre, it could not be cited in favour of adopting alternating current systems in small villages and towns. The original alternating system does not exist, in its place we find two distinct systems of mains connected through sub-stations, and these mains require to be special and costly, compared with the single simple system of bare copper mains required for continuous currents.

Other disadvantages of the alternating systems mentioned in the paper, although of minor importance, are only too true. Storage is at a disadvantage, and so also electric motors and meters.

There can be no doubt that the extension of the alternating system to fresh fields and pastures new has ceased, and that in time it will become obsolete, at any rate for town supply.

It is somewhat sad to reflect on the number of small towns committed to a system which in course of time will be superseded entirely if the full benefits of an electric supply are to be enjoyed. It will be but small consolation to throw the blame on their advisers.

Having severely condemned the indiscriminate adoption of a system with so many disadvantages, and which, instead of improving, is always becoming more and more complicated, the author of the paper proceeds to the discussion of the details of the continuous current systems.

This system has made slow but steady progress during its history. First as a simple two wire system with lamps varying in voltage from 60 to 110. Then as a multiple wire system, the intermediate wires not being connected to the generators. This system enabled the use of higher pressures but required perfect balancing. Then came the multiple wire system with the intermediate wires coupled to the generators, this is now in use as the three and five-wire systems, and is at present the best system for town supply of electricity.

The introduction of 200 volt lamps still further improved the continuous current system by enabling double pressures to be used, and twice the number of lamps to be fed from the mains previously designed for 100 volts.

The improvements which are sure to come in storage of electrical energy must all go to the benefit and advantage of the continuous system, and the time may come when the whole supply can be delivered from a store, and the load on the generators made constant all over the 24 hours of one day.

The author of the paper prefers multiphase systems among alternating methods, a complete system of this type is fully

described in the Electrical Review in seven articles extending from October till December 22nd, 1893.

No doubt in some cases, where for some good reason the power house is to be situated at a long distance from the centre of distribution, a multiphase transmission system would be the most advantageous, but these cases are so rare that not even one case exists here in town lighting.

The superiority of Crompton's bare strip, built-in system for running electric mains is very clearly recognised, but we are rather inclined to believe that an accident would result if the mains were submerged in water in the culverts; it is not reasonable to say that nothing serious would happen if the water were *pure*. Pure water is exceedingly scarce, any water which might enter the culverts would certainly be impure enough to conduct.

The other topics treated are not of much general interest although they should be carefully discussed by those engaged in the electrical distribution of energy.

STRIKE INSURANCE.

The *Engineer* reports, in a leading article, that a Sheffield employer is proposing a scheme of strike insurance, and has broached the subject to several large establishments. The affair is to be upon the lines of a mutual syndicate to which it is expected all large manufacturers, gas and railway companies would adhere. Apparently others who did not actually join the syndicate, so far as finding capital, could pay premiums against strikes, and would be supported by the insurance company. The prospect is not reassuring. It savours strongly of the tyranny of American capital, and the pity of it is that English capital has been driven to the idea by the tyranny of the trade unions, and has not evolved the idea from any deliberate and wilful intentions to crush labour. It cannot be held that for many years past English capital has made a bad or hard use of its powers. Capital has gone fairly peacefully on its way and has suffered squeeze upon squeeze, until now its profitable existence is threatened with an ending. The tactics of trades unionism have been to deliver concentrated attacks upon isolated firms or single towns. Obviously such individuals were soon put to rout, the contributions from the rest of the country keeping up an easy attack. In this manner, taken in detail, the whole country has been brought to heel by the trades unions. But in the successful pursuit of this warfare the unions, led by men of no intelligence in respect of the true interest of the country at large, have followed upon absolutely false lines, and have reverted a hundred years in their attitude towards machinery. Had the trades unions acted on true economic lines, their members would to-day have been better off in every respect, no strike would have been in progress, and employers would have been paying larger wages than even the trades unions are asking or thinking of, and English workshops would to-day be working two shifts a day of eight, or perhaps only seven hours each. The conditions of English life, of climate, of material resources and of geographical position, would have made all this possible with advantage all round, but that the workers have placed themselves body and soul in the hands of a class of men whose choice of the means to obtain their end has been marked by a fatuous folly without parallel in history. Employers are to-day fighting against an eight hours' day because they are getting such very poor output from nine hours, that they must inevitably be unable to afford eight hours at the same output; but there is no employer, we take it, who does not now know that he could very well afford eight hours if the men did an honest day's work. The life of a workman at present is not a pleasant one, for the simple reason that he must be up in the morning and get to work before he can make any use of his time. There is no time during the day except for meals, and even with an eight hours' day very little time in the evening for that *mental improvement* of which the A.S.E. makes such a song, but which Woolwich has proved to be synonymous with *bicycle making* in competition with the trade. Let us suppose that work commenced at 4 a.m., and that it went on until 12.30, with a half-hour interval at 7.0 to 7.30, and that a second shift commenced at 12.30 and went on to 9 o'clock with a half-hour interval at 5.0 to 5.30. We may also suppose that the two shifts alternated week by week or month by month, or that such as preferred it paired off and worked permanently in the same shift. Is it not perfectly obvious that such an arrangement would give the men a far easier and more rational life than is now the case. They would have a morning's or an afternoon's leisure every day. The present crowded Saturday half holiday would be evenly distributed over the week, the work of railway servants would be better distributed over the day and so would that of the shopkeeper. The office staff could be similarly arranged, while the management would properly extend over a part of each shift. The extra output from the buildings and plant would more than pay for the short hours of wage earners, and all this would be possible if the men would refuse to curtail output.

The suggestion of a double shift is not new. It has not only been broached before, but it has been carried out at the chemical works of Messrs. Brunner, Mond & Co., of Northwich. Originally they worked two twelve hours' shifts per day, now they work three shifts of eight hours with a bigger output per unit of wages, proving that an eight hours' day is better than one of twelve hours, though it does not prove that a nine hours' day would not be better than one of eight hours. There is no reason why in the manufacturing engineering trade a similar arrangement would not be satisfactory. Granted that at present there is not the work to be done, there very soon would be. Our works could take orders now going abroad; production would be cheapened and the unemployed would be absorbed. The A.S.E. method for making employment for all is to compel the workers to loaf at least a fourth to one-half of their time, so as to make work for the idle; but they cannot see that so far from effecting the purpose the only result of this childish folly is to give the work away to Germany or America, and put more men in England on the unemployed list.

To our mind the whole question appears more than ever one of a fair day's work for a fair day's pay, and not one of hours at all. The men are really fighting a mistaken battle, for they are fighting for the right to demand pay for work neither done nor attempted, and all experience points to their ultimate defeat. No perpetual motion scheme ever succeeded long in mechanics. Yet here we have men who call themselves engineers who are fighting for the principle of something for nothing, and they have raised up "*Insurance against Strikes.*"

THE DEVELOPMENT OF ELECTRIC CABLEWAYS.*

By RICHARD LAMB.

Large expenditures of thought and money have been made to devise means of transportation that can disregard the insurmountable difficulties of some surface roads, such as excessive grades, too much bridging, or too great a cost for roadway. The natural suggestion has been to make the roadway through the air, and air-ships, flying machines and suspended cableways have been sought for to solve the problem.

Macaulay wrote: "Of all inventions, the alphabet and printing press excepted, those inventions which abridge distance have done most for civilisation."

The most baffling problems we have before us to-day are those of abridging distances. With all the expenditure of life and money that has been put into the endeavour, man has not as yet even been able to traverse this orb of the universe upon which we are living, and with untold riches as the goal; thousands stop within a few hundred miles of the Klondike, at the first short pass, to await a less hazardous season to risk the journey.

There are millions of feet of valuable timber in swamps standing within rifle-shot distance of convenient points of navigation that have been practically unobtainable. The

* A paper presented at the 119th meeting of the American Institute of Electrical Engineers, New York, October 27th, 1897.

miry soil makes regular roadbeds too expensive, and it has been as impossible to get the teams into the swamps as to get the logs out. It was to solve this particular problem of abridging distances that my electric cableway was built.

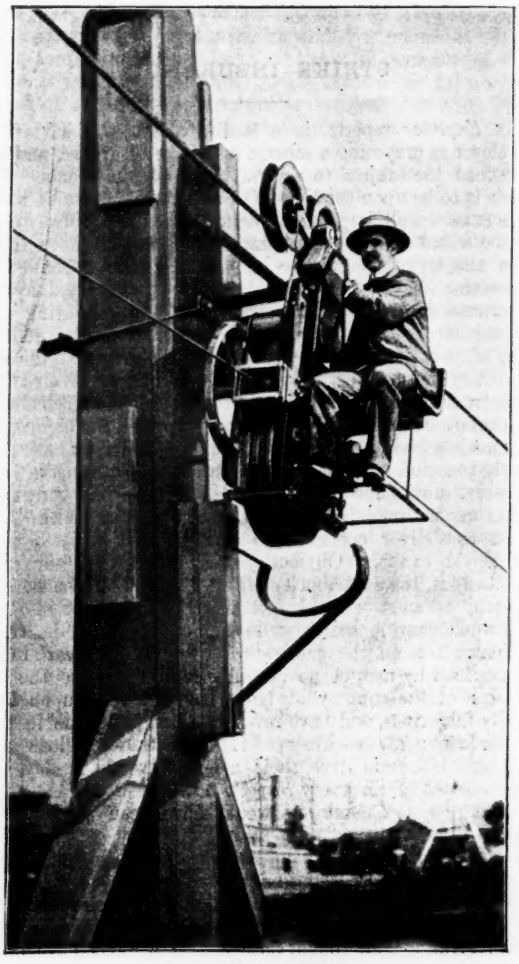
I first built a cableway, having portable iron bracket supports to attach to the trees, and an endless cable supported by sheaves upon the brackets. The cable was passed around a sheave which was driven by a steam engine at one end of the line. This cableway worked well, and could haul logs for a distance of half a mile, which is farther than by any other method previously tried. I found that steam cableways are limited to straight lines, and as trees do not always grow in long straight lines, I devised a means by which the car would replace the traction-cable in its sheave if it was dislodged in passing a bracket on account of the cable line not being straight. But this did not obviate the difficulty of having to select the route with reference to a straight line.

In the excellent article on "Railways in the Air," published in a recent number of *The Strand*, the writer states: "Two stout wire carrying ropes are laid parallel on standards of wood or iron and then stretched tightly *in a straight line.* (These words are in italics). Aerial rope-ways cannot run round corners." This condition is due to the fact that a moving cable has a tendency to work itself out of its carrying sheave, unless the line of the pull of the cable is straight. This fact suggested to me the necessity of the traction cable being stationary. It was a natural advance in the line of thought to note that if a sheave would transmit sufficient power to haul logs a distance of half a mile from the same, that it would be even more efficient if the power applied to the sheave was near by and accompanied the load on its travel. As an electrician, the cables of the steam rig naturally suggested to me conductors for an electric motor that would operate the sheave. Such a motor admits of the traction cable being stationary by passing it about the sheave several times and anchoring it at both ends; thus, the motor winds in and pays out the cable, on the principle of a capstan. The fact that the traction cable is stationary, and that the lower bracket catches the cable as the motor passes, makes a system of this kind the only one that can be operated upon concave and convex curved lines.

One of the essential features of the steam cableway is having the traction rope always parallel with the bearing cable. The disregard of the direction of forces in other cable systems has been one of the main causes of their failure. On approaching a support the cable naturally sags, and the carriage has to be propelled up an incline. If the grade of the cable is steep, as it is in practice, and the power is applied in a horizontal direction, the resultant force will neutralise the pull, and the carriage will stop. Cableways, operated by horses on the ground, pulling the carriage on the cable, have accordingly been inoperative. It was important, therefore, in the electric cableway, to have the traction cable always parallel with the bearing cable. Supposing the incline of the cable is raised until it is vertical, we would then have an elevator; the bearing cable being the guide and the traction rope the hauling rope, the motor being on the elevator car instead of at the top or bottom of the shaft. It is this feature that enables this system to operate on grades that would be impracticable by other methods.

This system consists of a carriage with grooved wheels in tandem that move upon a cable or suspended trackway. From this carriage is hung a frame, pivoted to the carriage so that it can maintain a vertical position regardless of the grade of the track. This frame holds an electric motor, preferably of an ironclad cylindrical type. The motor is geared to an elliptically grooved sheave. A steel cable is wrapped around this sheave two or more times and is anchored at both ends. For the sake of economy in conductors, the upper or bearing cable is insulated from the lower or traction cable, and is used to carry the electric current. The carriage is insulated from the suspended frame and motor. An insulated wire is attached to the carriage and conveys the current to the rheostat. The other pole of the rheostat is connected with a convenient part of the suspended frame. The rheostat is designed to control the speed and reverse the current. A circuit breaker is put in circuit. Tracing the current from the generator, it passes along the bearing cable to the carriage, thence through the insulated wire, through the rheostat, to the frame of the motor, thence through the traction cable back to the generator. At intervals along the line connection is made between the traction cable and the ground. A bar of copper-coated iron is buried at the foot of a tree or post to which the cable brackets are attached. A well-bonded copper wire extends from this ground plate to a lower bracket, upon which the traction cable rests. In swamp and canal service the plate is buried well into the moist earth. A most marked difference in the resistance is noted when the ground connections are disconnected. When connected, the resistance is the same as if the traction cable was the same size as the bearing cable.

In making the first saddles to support the cable, they were designed for movable brackets, which can be easily put upon trees and removed to other trees when the line is changed to a different location. These saddles have a U-shaped clamp that goes over the cable and is bolted down with wedge-shaped bolts. Under the saddle is a petticoated recess,



"Finow," Canal Motor.

designed to shed rain water from the insulation placed between the saddle and the bracket to keep the current from grounding or short-circuiting.

This develops a new feature in insulation. It appeared that many of the materials ordinarily serviceable for insulating were not available, owing to the fact that often a rolling load of 10,000 lbs. or more passes over the brackets, producing a grinding and crushing effect.

Lava, hard rubber, micanite, shellac, mica and its products, glass, porcelain, ozite and all products of rosin, proved to be too brittle. Vulcanised fibre was finally used, and proved quite satisfactory for a time. As only 220 volts are used in logging plants, and as it is an advantage, from a construction standpoint, to have the insulation as thin as possible, sheets of fibre, $\frac{1}{8}$" thick, were used. It was found that although this insulation was protected from the rain, by being shellaced and covered by a petticoat, after being exposed for

some time it would lose a considerable amount of its resistance, and while some of the brackets could be passed by the electric motor, the heavy load on others would cause a short circuit through the insulation. This was averted by painting the saddles, brackets and fibre with insulating paint, and by increasing the thickness of the insulation to $\frac{1}{4}''$, and using fibre that had been solidified under unusual pressure. This was found to work all right.

The saddles for the plant for the Erie Canal towing test, referred to hereafter, were made so that the tread of the bearing wheels would leave the rope, and the wheels would pass over the saddles on their rims, guided by flanges cast upon the saddles. On curves these flanges were made concave or convex as required. These saddles worked excellently, and the motor passed over them easily and satisfactorily. These brackets were insulated with ozite and vulcanised fibre, and painted with insulating paint.

Work in swamp logging demonstrated that small short saddles are all that are needed, even for deflections in the line of from 20 to 25°. The saddle was much simplified by attaching to the brackets an insulated cone-shaped pin, over which the saddle is placed, by having a cone-shaped recess in the under part of the needle to fit the pin. This recess also acts as a petticoat to protect the insulation. The question of insulating the cone-shaped pin was an important one. Vulcanised fibre could not be moulded upon the pin. A material was needed that, while having a high resistance, would adhere to the pin, and that would stand a great crushing strain. It should be preferably non-hygroscopic, and show a minimum absorption of water.

(To be continued.)

THE RÖNTGEN SOCIETY.

The inaugural meeting of the recently constituted Röntgen Society was held last Friday week in St. Martin's Hall, when the presidential address was delivered by Prof. S. P. Thompson. There was a large assembly of the professors and admirers of "the black art of skiagraphy," as it was very aptly named by the president.

The walls of the hall were covered with the productions of the black art, the blackest of all being Dr. Morton's photograph of a full length figure taken at a single exposure. Though these "skiagrams" cannot be considered to be things of beauty, they are undoubtedly of great scientific interest. In the President's opinion the application of the Röntgen rays to surgery constitutes the greatest advance that has been made since the discovery of anæsthetics and the antiseptic treatment. Amongst the photographs exhibited may be mentioned as of special interest the photograph taken by Mr. Abbott at the seat of recent Græco-Turkish war, and the microskiagrams of sections of sodium-gold alloys, showing the internal constitution of the alloys, by Mr. Neville.

The exhibition of apparatus was probably the largest that has hitherto been got together, and speaks well for the activity of our scientists and instrument makers in this field. Mr. Mackenzie Davidson's apparatus for determining the exact position of a foreign body, shown on the skiagram, was exceedingly ingenious in design, and with a little practice, could be very easily manipulated. The focus tube is suspended on a graduated horizontal bar, and skiagrams, say of a needle point imbedded in a hand, are taken with the lamp in two different positions, which are read off on the scale. Two images of the needle point are thus formed on the photographic plate. On another frame the paths of the rays passing through the point of the needle in the two positions of the lamp are represented by two threads, whose intersection gives the height of the needle point above the plane on which the hand is resting. This determines, let us say, the z co-ordinate of the plate; x and y are determined by two crossed wires placed between the plate and the hand when the photograph is being taken. These wires are photographed on the plate by the X rays, and they mark the palm of the hand with aniline dye which has been previously brushed over them.*

Induction coils, with motor and other specially-designed breaks, were exhibited in great variety; the largest coil being a 20-inch Apps-Newton, used by Mr. Webster to show the interior of the living body on the fluorescent screen. But the most interesting generator was a Tesla oscillator, exhibited by the President. This is the first Tesla oscillator which has been exhibited in this country, and is said to equal, if not surpass, the largest induction coils in the production of Röntgen rays. With a unipolar tube and this oscillator, Tesla has shown the bones of the hand on a screen at a distance of 50 feet from the lamp. The oscillator exhibited was small and compact, and was worked by a current of about half an ampere, taken from a lighting circuit; direct or alternating currents may be used. If the construction of this oscillator be the same as that patented by Tesla last year,* it is simply an induction coil in which the oscillations in the primary circuit are maintained by timed impulses from the supply circuit. The spring break is timed to oscillate synchronously with the electrical oscillations in the primary circuit, and by this means very small impulses from the supply circuit may give rise to very large oscillations in the primary. The strong high frequency oscillations thus generated in the primary are transformed up to the required tension by a secondary coil of moderate length.

The President in his address gave an excellent *résumé* of the history of the new science. As most of this history is already well known to readers of the Electrical Review, we shall mention only a few points which appeared to us to be of special interest. Speaking of the inflammatory effects of the rays, the President remarked that this appeared to occur in certain persons only; he himself, for instance, had never suffered in this way. One observer had discovered that in some cases the internal tissues were inflamed, and in other cases the burn had been discovered on the opposite side of the body from the lamp. The most plausible explanation yet suggested was that the burns were due to the increased chemical activity of air ionised by the X rays. Prof. Brandes had found that in certain circumstances the retina of the normal eye possessed a faint perception of the X ray, but there was very little reason as yet for supposing that the blind, by this means, would be able to see. As to theories Prof. Thompson appears at present to be inclined to think that the Röntgen rays are some kind of wave motion. The equality of absorption and emission, in which the rays follow the same law as ordinary light, seems to him to furnish *prima facie* evidence in favour of a wave theory.

Some indication of the phenomenal development of the infant science may be obtained from the fact that several books on the subject have already been published, and three journals—one in England, one in America, and one in Germany—have been established for the publication of observations and discoveries in connection with the Röntgen rays. The new Society has got a good send off, and we wish it every success.

BEHR'S LIGHTNING EXPRESS.

[COMMUNICATED.]

Very few details have reached this country of the practical working of Behr's Lightning Express at the Brussels International Exhibition. The car was made by the Gloster Railway Carriage and Wagon Company, Limited, and Mr. Ralph Platt, who has just returned from Brussels, where he has spent six months as the representative of the company, gives some interesting facts in connection with the railway, in which great interest is still being taken in engineering and railway circles. The railway is constructed at Tervueren, about six miles from the Belgian capital. It is constructed on the Lartigue monorail system (the single rail being at the apex of an inverted V-shaped structure) and is about three miles long, being in form elliptical, *i.e.*, two straight lines joined at each end by a curve of a radius of about 1,500 feet. The car is about 59 feet long. The lower part consists of two bogies, connected with each other by a special joint. These bogies contain the main and guide wheels and

* See Electrical Review, Vol. 41, p. 644.

* See British patent No. 20,981, A.D., 1896.

the electric motors. The upper part consists of a single carriage body, with seats for 100 persons, a compartment for the electrician in front, and one for the conductor at the rear. In the electrician's cabin are two brakes, by one of which the resistance of the air is used for slackening the speed of the train when travelling at its highest velocity, the other, an ordinary friction brake, acting on the wheels for finally stopping the train. Each bogie has four carrying wheels, viz., eight for the whole carriage, to four of which are attached electric motors weighing about three tons each and developing 150 H.P. at 600 revolutions per minute. Each bogie also carries 16 horizontal guide wheels. Their principal object is to maintain the equilibrium of the carriage and to transmit to the guide rails the pressure produced by the centrifugal force, which is developed by the carriage in going round curves. The line itself is constructed so as to easily resist any pressure which may be produced, and it is chiefly the construction of the line in its relation to the guide wheels and the carriage generally, which enables the train to travel at the rate of 100 miles an hour without danger of derailment. The total weight of the carriage is about 50 tons, and it is estimated that the pressure exercised at a speed of 100 miles an hour by the centrifugal force is about 18 tons, so that the tractive power required is increased as if the carriage had an additional weight of 18 tons. The construction of a similar line along one of the great trunk lines of Europe would be, it is stated, £8,000 or £10,000 per mile, but it is estimated that the difference in the working expenses as compared with ordinary railways would, where a large passenger traffic could be assured, make it commercially profitable. Mr. Platt says that the railway was to be closed on the 15th inst, but it is expected that the car will remain there during the coming year, when certain experiments will be watched by a commission of engineering experts specially appointed by the Belgian Government.

The car runs very satisfactorily, and the internal fittings have been very much admired. It is claimed that a speed of 100 miles an hour has been obtained, which is considered highly satisfactory under existing circumstances. The electric current is provided by the Belgian Government, but owing to some mistake they are unable to give a constant supply of it; in fact, they are unable to retain the maximum and necessary current for over two minutes, and thus it is impossible to reach a higher speed. The running of the carriage is universally admitted to be much easier than an ordinary railway carriage, the vibration and oscillation being much reduced. Among the distinguished passengers who have travelled in the car may be mentioned H.R.H. Prince Albert, the heir apparent to the Belgian throne; M. le Comte d'Oultremont, Commissaire General for the Brusselles Exposition; the Belgian Prime Minister and other Government officials. All expressed themselves highly pleased with the easy running. Gold medals have been awarded to the firms represented in the construction of the railway and carriage, and this is considered satisfactory, as it is whispered that the jury were very antagonistic to the scheme, saying that the system was unsafe. The car has run about 2,000 miles up to the present, without accident. The experiments next year will doubtless be watched with great interest, and it is hoped to attain a still higher rate of speed.

SOME NOTES ON THE ELECTRO-DEPOSITION OF ZINC.

By SHERARD COWPER-COLES.

The chief difficulty attending the electro-deposition of zinc is the formation of zinc sponge. The presence of free acid appears to accelerate the formation of this zinc sponge, as is strikingly illustrated by figs. 1, 2 and 3. Each experiment was of about 17 hours' duration, the same solution and rolled zinc anodes being used in each experiment. Fig. 1 illustrates a zinc deposit upon iron obtained in the first experiment from a freshly-prepared zinc sulphate solution, a fringe of zinc sponge having been formed around the plate at the water line. Apparently, as the electrolyte became more acid, so the amount of zinc sponge increased, as illustrated in figs. 2 and 3, which show the test plates obtained in the second and third experiments. Zinc anodes appear

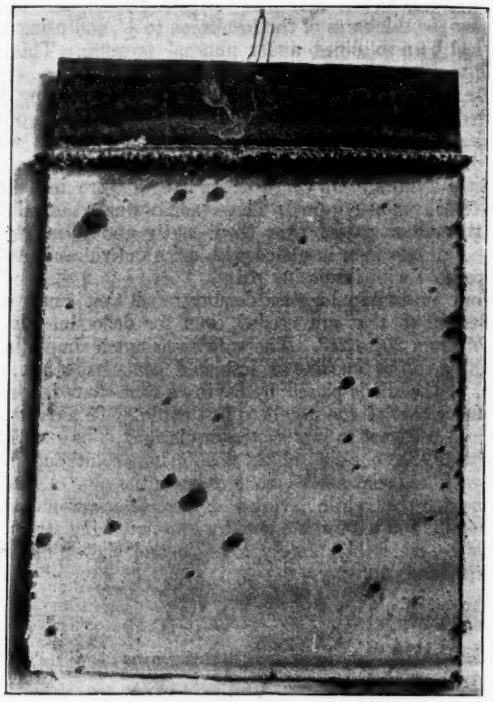


Fig. 1.

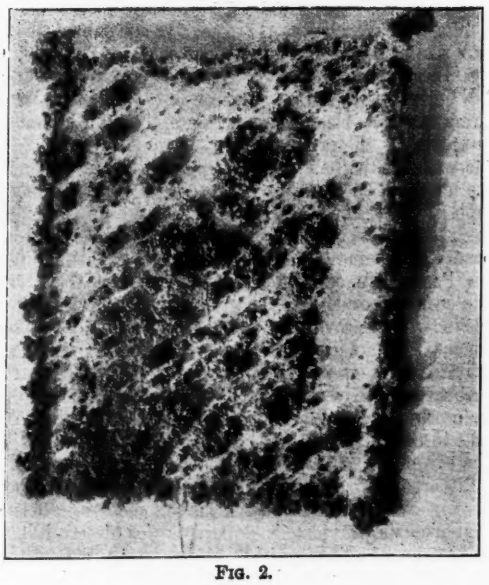


Fig. 2.

to be incapable of keeping the zinc in solution up to its original strength, even when the anode surface is in excess of the cathode surface, as illustrated by the following experiments:—

Experiments to determine the difference of loss of anode and gain of cathode. Composition of electrolyte, 40 *ozs. of zinc sulphate (crystallised salt) to the gallon of water.*

No.	Weight of zinc deposited on cathode.	Weight of zinc dissolved from anode.	Difference between amount deposited on cathode and dissolved from anode.
1	12·191 grms.	11·171 grms.	1·02 grms.
2	22·074 ,,	20·39 ,,	1·684 ,,
3	33·511 ,,	30·51 ,,	3·001 ,,

The figures were collected as a side issue to some experiments on the comparison of deposits from various zinc solutions, consequently the solutions in which the anodes were immersed had long rests and short periods of working, which

Fig. 3.

were very favourable to the solubility of the anodes. The figures in the second column above ("Dissolved from Anodes") were obtained by encasing the anodes in muslin bags, and weighing the detached scale with the anode.

THE HEILMANN LOCOMOTIVE.

A *Times* correspondent describes a journey from Paris to Nantes, in a train drawn by an electrical locomotive—our old friend the Heilmann, in fact. The train weighed 150 tons, and was made up of 13 vehicles. The object was not to make a trial of speed. The speed trial is to come later. The train weighed, as stated, 150 tons, and ran at a speed of 18 miles an hour. Shortly, the train is to weigh 200 tons, and run at the magnificent speed of 25 to 30 miles per hour. Later, a 300-ton train is to run 62 miles per hour. Here further progress is veiled from our eyes, but there seems to be indicated for our absorption a possible 1,000-ton train at an enormous velocity. But more follows, for it is added :—"But what has not yet been seen here, nor probably elsewhere, are heavy trains, even goods trains, capable, without extra cost and without wear and tear of the line or the rolling stock, of attaining a speed equal to that of the fastest passenger trains, and making the distance between Marseilles and Paris half a day's journey, whereas at present heavy merchandise loaded on heavy trains takes a week, or even two, to cover that ground."

This is one of those statements made by irresponsible non-technical journalists which has no solid basis of argument. Because French goods' trains are so slow, we are asked to believe the new locomotive is something very wonderful, and we are also asked to believe that a part electrically-drawn train will not have the resistance, wear and tear of a steam-drawn train. There is a lot more nonsense, based on the easy gliding motion of a train at 18 miles per hour, as to the successive jerks due to the alternate movement of pistons. At the same time, the movement at starting of this French train reminds the journalist of an English train, all which seems to point to the usually faulty coupling of French trains, rather than to any special virtue of the new locomotive. But the idea that any irregular action of a 60-ton engine can arise from its piston alternations, is very far fetched. A 60-ton fly-wheel will steady 1,000 horse-power when generated by a single piston at only 60 revolutions per minute, and what is a 60-ton locomotive but the exact equivalent of a fly-wheel with two pistons at much more than 60 revolutions per minute ?

The Heilmann engine will, like all electrical motors, have a powerful and steady tractive force, but we do not believe its coal consumption will be less than that of an ordinary locomotive, even with all its six cylinders and dynamo and motors. This Heilmann engine has been years before the public, and the experimental phase was claimed to have been passed with the first engine, named, we believe, La Fusée, and the present engine was to have embodied all the virtues, while discarding the vices, if any, of its predecessor. Yet it crawls along at 18 miles speed for its public performance, as though its friends doubted its principles or its capacity. We have always urged that the Heilmann principle was not necessary for the purpose of demonstrating the possibilities of electrical traction, and we still think that the advantage of a great haulage effort, which can, of course, be obtained by running the engines at a high speed for a slow forward movement, are obtained at too great a complication. To be of real service, it would, in fact, appear that the Heilmann engine is better suited to long and heavy goods traffic than to fast passenger work.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The opening meeting of this winter session was held at the Institution of Civil Engineers, on Thursday evening last. The President, Sir Henry Mance, occupied the chair. The first business was the publication of names of those whom it is proposed to include amongst the Council, and as officers for the ensuing year. The list issued by the Council in office is as follows :—

President :

Joseph W. Swan, F.R.S.

Vice-Presidents :

Prof. S. P. Thompson, F.R.S. — *W. E. Langdon.*
Prof. John Perry, F.R.S. — *James Swinburne.*

Ordinary Members of Council :

S. L. Brunton. — Dane Sinclair.
Prof. J. A. Ewing, F.R.S. — Herbert Taylor.
W. P. J. Fawcus. — Charles H. Wordingham.
Major R. Hippisley, R.E. — Henry Edmunds.*
Prof. J. A. Fleming, F.R.S. — *Robert K. Gray.*
E Manville. — *P. V. Luke.*
J. S. Raworth. — *W. M. Mordey.*
A. A. C. Swinton.

Associate Members of Council :

H. W. Miller. Sydney Morse.
Sydney Evershed.

Honorary Auditors :

F. C. Danvers.* *E. Garcke.*

Honorary Treasurer :

Prof. W. E. Ayrton, F.R.S.*

Honorary Solicitors.

Messrs. Wilson, Bristows & Carpmael.

For election : Names in italics. For re-election : *. Others remain in office.

The president, in publishing the foregoing list, mentioned that Mr. Robert K. Gray had been offered the presidential chair, but had stated that he would be unable to accept. His name, therefore, appears amongst the ordinary members of Council for election.

Mr. Epstein then read his paper on "Accumulator Traction on Rails and Ordinary Roads." He dealt first with the method of working such lines as have been operated by accumulators, proceeding to consider the ideal requirements of a suitable cell for the work, and how far these have been reached in practice, passing on to the cost of depreciation, and concluding by a short discussion of battery traction on common roads.

The first speaker in the discussion, after remarking that as a civil engineer he was more acquainted with the currents and pressures that can be confined in a cast-iron pipe, gave some particulars respecting a new accumulator that is being tried on the Dresden tramways. The plates are pasted with ordinary salts of lead, which give a very hard coherent coating, never breaking up, but yielding large capacity. The present form of plate measures 11 cm. by 27 cm.; 13 plates are included in one cell, which weighs 13½ kilos. Notwithstanding the small surface a high efficiency is obtained. The normal discharge is 65 amperes, on emergency up to 120 amperes can be taken without deformation of electrodes. These cells are worked 17 hours daily, and have run 130 miles without any charging. On one occasion the battery in one car was subjected to 500 volts; the car caught fire, but the battery was capable of doing its work afterwards, notwithstanding. The six or seven months' trial has proved very satisfactory. The maximum discharge per kilo. of plate is 9 amperes; the normal discharge is about 1 ampere for about 6 or 7 square inches of + plates, and the maximum 1 ampere for 4·6 square inches, which the speaker considered exceeded anything obtained before. Experiments on the cell are now being conducted in Belgium and France.

Mr. Crompton considered the subject dealt with in the paper must be interesting to all electrical engineers, as we are on the verge of traction schemes being extensively carried out. More particularly he alluded to the very bold experiment of the London Electric Cab Company, from which, if it goes on as well as it has begun, we shall know more of the possibilities than at one time was thought there was any likelihood of doing.

An American inventor had attempted to deal with the crumbling away of active material where accumulators are used for land purposes—increased by the vibration on a road and moving machinery—by encasing the whole of the plates with rubber in a soft and plastic form; each of the + plates was covered with a diaphragm, in which were properly formed apertures, giving free access and elastic support to the active material of the plate. This seemed to the speaker a very clever notion, as the rubber was soft, but held up and backed the active material. Something of the sort is wanted to enable a further advance to be made.

Referring to the tractive force on ordinary level roads, the figure for which Mr. Epstein put down at 60 lbs., it was considered that although that given was rather startling, the speaker thought the figures given warranted, and even believed that with a cab they might be less. Ravenshaw and other engineers had found that with pneumatic-tyred vehicles the tractive force need not exceed 28 lbs. per ton. If that is so it follows that we may run such vehicles at 10 miles per hour for just over one actual horse-power exerted, or it may be said that with 1,400 watts such a cab could be driven at 10 or 11 miles per hour. As efficiency is increased the weight of the different parts can be decreased.

Mr. Crompton wished the cab company well in every way, and it made electrical men very proud to see that after all the electrical motor cab is the only satisfactory one on the road.

Major-General Webber expressed his regret that something had not been said regarding the experience with the accumulators on the Birmingham tramway line. It fell to his lot to deal with that matter, and Mr. Snell, now the borough electrical engineer of Sunderland, had remained at Birmingham making observations on the results of that line. The speaker believed that the system there had been allowed to be very much misrepresented. When the writer of the paper spoke of what the system of charging and moving the cells should not be, he may have had Birmingham in his mind. The speaker had been informed that this system led to a loss of 60 per cent. of the electrical energy generated by reason of faulty construction.

It was to be regretted that some concern had not been induced to adopt accumulator traction with those faults remedied. It would be interesting to know if the ideal cell does exist, and if the results claimed for it could be produced by the writer of the paper himself, or other makers.

As regards means of reducing the necessary tractive force, experiments were made by the Electrical Power Storage Company on an omnibus which for a few minutes carried three Cabinet ministers while on a trial trip along the Embankment. Mr. Frank King had spent an immense amount of time, and exercised great ingenuity, in connection with this vehicle. The pneumatic wheels used, however, possessed a very great element of resistance to tractive force, notwithstanding the great pains which were taken with these wheels. By a sketch on the blackboard, it was explained that the weight on the wheels caused the circular section of the wheel to be flattened, and an increased surface was brought in contact with the roadway. Major-General Webber asked the meeting to consider the section of a wheel, which will be one of the solutions of the subject. This may be described as a solid India-rubber tyre, mounted on a steel channel-shaped ring, the channel forming a hollow space filled with compressed air. By this means the width of area resting on the ground becomes very small, and would go far to reduce the tractive force, even more than the extent referred to by Mr. Crompton.

The speaker hoped that Mr. Epstein would, in his reply, particularly deal with the question of tramways, owing to what many municipalities have urged as objections in the overhead wire systems, while anything more intricate, more costly, and less likely to be followed than some of the means suggested for underground conduit or slot systems, Major-General Webber could not conceive. The question of accumulators has a double interest in the United Kingdom, as what is being worked out in Dresden will also have to be worked out in this country.

Mr. Manville considered the writer of the paper deserved the warmest thanks of the Institution; he had an idea himself of saying something, but Mr. Epstein's ideas were his, and all the more important features are referred to in the paper. The speaker had the fortune, or misfortune, to be connected with the Birmingham tramways, and he owed many of the grey hairs he had to that fact. The cost of renewals do not make the system uncommercial; the real expense connected therewith, is not so much the accumulators themselves, as the effects they produce, and the handling of the cells. The staff is also very considerable, and forms quite an appreciable item in the cost of maintenance of the cells.

Cells should certainly be carried independently of the car. Many more chances of commercial success are obtained than by any other way. Lately Mr. Manville has made a number of experiments on accumulators while stationary as well as when violently vibrated during discharge. Some types proved to be good and others bad, but the curious fact was noted that none of the cells vibrated were worse than those that were still. That is important, because people thought that vibration had a direct influence in lowering the efficiency. The chief reason for wear and tear is due to the stringent electrical conditions under which cells are handled—the heavy discharges, for example, to which they have at times to submit.

The proportion of weight of cells in a tramcar is, say, 1 to 3½, but it is quite feasible to put a much heavier proportionate weight in light-weight vehicles, say 1 to 2¾ or 1 to 3, and that difference will have great effect on life of cells. On common roads it is not so much smoothness as hardness that is wanted, and while the traction force need not exceed 60 lbs. per ton, it is safe to put it nearer 40 lbs.

In reply to Prof. Ayrton—who wanted some actual figures about cabs, size of motors, average and maximum power of cells—Mr. Manville said that the motors on the London cabs were of 3 kilowatts input, with double wound armature and fields, the 40 cells were kept always in series. His own experience was that on wood pavements 30 amperes were taken at 80 volts, this rises to 40—45 amperes on roughest kind of hard road, although he had seen the current go up to 120 amperes on one occasion.

One or two other speakers criticised the method of testing cells by vibrating them in a laboratory. In actual work it is considered that the extremely rough usage comes from the jumps and jolts which accompany the passage of a vehicle, say, over rough granite. Mr. Manville remarked that pasted and Planté cells had shown equally good results, and that they were placed on a cradle for test, which was hung from a complicated system of eccentrics, rods, and countershaft, the eccentrics being out of centre, and the shafts being driven one from the other by a loose rope.

Another query put was as to the feasibility of using a series parallel device to enable different voltages to be got from

the cells for different speeds, as some consider differential forms of gearing to be wasteful, noisy, and troublesome.

At this point the discussion of Mr. Epstein's paper was adjourned until the 25th of the current month.

CORRESPONDENCE.

Professor Jamieson's "Elementary Manual of Magnetism and Electricity."

I was somewhat disappointed with your hypercritical review of my book in your issue of the Electrical Review of last week. In the first place, this book, as a whole, only saw the light in September, 1890, and the fourth edition was printed by the end of March, 1897, but only issued in September of this year.

With regard to your second paragraph, I quite agree that applied electricity and magnetism have made rapid progress during the last few years, yet the fundamental principles and experiments with which my book professes to deal have not altered since 1890, and, consequently, the matter and illustrations are still in "*phase*" with "*current*" ideas. Would you kindly plot out the "*lag*" curve for the fourth edition, taking full account of the "*reactance*" due to the stereotyping of the first edition. Will *you* undertake to publish a book and to reset the type for each new edition which is published at 3s. 6d. and sold to the public for 2s. 8d., which sum has also to pay all the bookseller's commission.

You seem to have only observed four new pages. Let me tell you that since the first edition was issued there have been over 150 corrections and additions made to it. Some of the more important additions, besides those you mention, are :—(1) Instructions for writing home exercises—one new page; (2) S. and A. Examiners' reports 1893 to 1896 inclusive—one new page; (3) p. 16, new fig.; (4) p. 49, new fig.; (5) p. 68, new fig.; (6) p. 77, new inclination tests; (7) p. 86, two new figures and text; (8) p. 116, entirely changed and with three new figures; (9) p. 139, two new figs. and reprinted; (10) top figure p. 140 changed; (11) p. 178 added to by half page; (12) p. 292, new figure and text. In addition to the above, each question set at the S. and A. Department's elementary examinations from 1890 to 1896 has been carefully assigned to the end of each lecture to which it belongs, and the 1897 examination printed at the end of the book. This gives both teachers and students as little work as possible in finding suitable questions, since the number of the lecture and of the questions have only to be written on the blackboard.

I quite agree that Henley's old-fashioned instrument which he called a "quadrant electrometer," would be better called an electroscope, even though it is provided with a scale. I shall replace it in the next edition by Lord Kelvin's latest "Gold Leaf electroscope"! The detector illustrated was made by Messrs. Woodhouse & Rawson, and they also supplied the electro of the same. When speaking of the land and marine mirror galvanometers, and the siphon recorder, &c., invented by Sir William Thomson, it would be out of place to call them Lord Kelvin's. The variety of "voltaic cells" is innumerable, and in an elementary manual it would only confuse the student if a great many were illustrated and described. Besides which, the Science and Art Department's elementary examination demands a knowledge of nothing more than is contained in the book, and every question that has been set for the last 20 years can be answered from the text, and in addition in certain practical directions the manual goes considerably beyond the Department's syllabus, with the view of making it generally more useful and more abreast of the times. Would you kindly point out "many illustrations of apparatus insulated on . . . . impossible electroscopes"? The electroscope illustrated in Lecture XXII., page 213, is an exact copy of the one I use, and it is believed to be the largest in existence. It will keep its charge for 12 hours, and the leaves can be seen by each member of a class of 150 students. I find that thoroughly good glass, when well cleaned, heated, varnished and dried, makes as good an insulator as you can get for class demonstration purposes, more especially when it is kept dry by being put in front of the excellent form of warming apparatus illustrated at page 292 for the first time in the fourth edition. My junior day students have to make and try experiments with the things illustrated in the different appendices, and the evening students are encouraged to do so at home; at least, their attention is as much directed to the appendix for each lecture as to the instructions for home exercises, the S. & A. questions and the examiner's reports. In my more advanced text-book on "Magnetism and Electricity," now in preparation, and "Elementary Manual of Electrical Engineering," now in preparation, I shall have to give an account of the latest development, but I fail to see the use of overloading a beginner, more especially an evening student beginner, with more than he can master in one winter course.

Andrew Jamieson.

The "Peroxide-Pot" Battery.

One of the most useful and remarkable batteries, which would be better appreciated if it were better known, might well have been mentioned in Mr. Gatehouse's retrospect. It was described in your issue of September 13th, 1895. Only one of these cells is allowed in charging a portable accumulator, for each accumulator cell in series, the E.M.F. of the former being quite $2\frac{1}{2}$ v.

D. G. FitzGerald.

Wireless Telegraphy.

In *Le Mouvement Economique de Bruxelles* of February 27th, 1892, under the head of "Telegraphie sans Fils," is a description of a patent granted to Thomas Alva Edison for a system of transmitting electric signals without the interposition of electric conductors.

An abridged translation of this article was embodied in a paper on "Coast Telegraph Communication," read at the meeting of the Balloon Society of Great Britain on March 18th, 1892. With your kind permission I will here repeat it in parts.

He (Edison) says he has discovered that if one places oneself at a sufficient height not to be interfered with by the curvature of the earth . . . . one can transmit from distant points telegraphic messages, or signals, by means of induction, without being obliged to unite the two stations by means of wires. This discovery is especially applicable over a large expanse of water, or to make communication between two ships, or to establish communication between a ship and the shore. In the last case, to augment the height of the point of reception to the earth, he would employ balloons. At sea, at an elevation of 30 metres communication can be transmitted to great distances, and the masts of ships supplied with metallic plates is all that is required.

Connection with the earth is established, and the secondary circuit of an induction coil of high resistance is placed between the surface of a condenser and the ground. The primary circuit is provided with a battery and some arrangement to produce signals. Closing the circuit produces inductive pulsations in the secondary circuit, which are transmitted to the condenser, whence they are transmitted by induction across the air, and are received by the electromotograph connected with the distant condenser.

Now, although this system devised by Mr. Edison differs in the method employed of causing and transmitting the electric impulses, there are some points of similarity that are very striking, the employment of balloons, for example, to raise the metallic collecting plates sufficiently high to overcome terrestial absorption, and the use of metallic plates at an elevation of 90 to 100 feet (about 30 metres) on land and on the masts of ships, as interceptors or collectors of these impulses.

It is only just to Mr. Edison to call attention to these points.

In view, therefore, of Prof. Minchin's priority in the question of the collecting wire for Hertz waves, and Edison's practical adoption of elevated conductors to wireless telegraphy, some of the most important features in Signor Marconi's system appear to have been anticipated.

H. Benest.

November 16th, 1897.

Dust Destruction at Shoreditch.

I am nearly tired of continually contradicting the absurd reports which appear in the public press, and also the letters which have lately appeared in your valuable journal.

As to the opinions expressed in this week's issue by your correspondent, "A Humbug Hater," who, I think, hits the nail on head by his signature, for all he says *re* the Shoreditch destructor. We are absolutely raising from our ashbin refuse sufficient steam to drive our electrical plant, giving a maximum output, at our heavy load of 250 kw., and this we are raising solely from ashbin refuse.

Our plant was designed to burn 22,000 tons of refuse per annum, but at the present time we are burning an amount considerably in excess of that total, and then cannot get sufficient to store over Sunday. Our dust carts only collect up to 1 o'clock on Saturdays, and we do not send them out collecting on Sundays, consequently we have either to burn coal from Saturday night to Monday morning, or put our streets in darkness, and if this is not definite enough, I should like some of your intelligent correspondents to give me a vocabulary suitable and I will use it.

What other towns can do, we neither know nor care, but what Shoreditch is doing is quite another matter.

pp H. E. Kershaw,
Chairman of Shoreditch Lighting Committee.

November 11th, 1897.

Electric Lighting of Railway Trains.

Will you permit me to make one or two corrections in the paragraph on page 651 in your last number, relating to the use of electricity for lighting trains? In addition to some vehicles devoted to Continental traffic, the South-Eastern Railway have at least one complete train electrically lighted—viz., the new vestibuled train on the London-Folkestone service. The London and North-Western *have* gone further than lighting the Royal saloon in this way, for several of the sumptuous new trains recently put on the suburban service between Euston and Watford are fitted with electric light. Lastly, the small company known as the Furness Railways, though Mr. Langdon ignores it altogether, deserves considerable credit in this matter. For some years it has possessed vehicles lighted by electricity, and all new stock is supplied with this means of illumination. These cases I have all come under my personal observation, and in all a dynamo with two sets of accumulators is provided for each vehicle.

R.

FIGURES FOR ELECTRIC TRACTION.

In the course of a very able and interesting address to the Institution of Junior Engineers by Mr. J. A. F. Aspinall, attention is directed to the errors in Mr. George Forbes's article on "Electric Power for Trunk Lines," which appears in the *Engineering Magazine*. Mr. Forbes gave the train mile expenses on the Liverpool overhead electric line as 3·84 pence per train mile, and as 11·76 pence on the Metropolitan Steam Railway. Mr. Aspinall does not consider the comparison a fair one, because the underground works under unfavourable conditions, and the figure 11·76 includes carriage repairs and renewals, items not yet incurred at all in Liverpool. Analysing the railway report for himself, Mr. Aspinall finds that the Liverpool line cost 3·67 pence per train mile for locomotive power, exclusive of renewal charges at the central generating station. The trains only weighed 38 tons, and the journey speed was 12¼ miles per hour. Comparing the figures with those of an ordinary railroad in open country between towns 20 miles apart. The train weighed from 117 to 148 tons, the locomotive 56 tons, the speed was 57 miles per hour between stations equal to 37 miles per hour journey speed, the slower trains making a journey speed of 15½ miles only. The day mileage was 1,787, or about equal to that on the Liverpool line. The locomotive power figures out to 5·87 pence, and it is evident that Mr. Forbes's comparison is not fair in view of the difference of speeds and weights.

Taking another method of calculation, the electric line shows on a six months' mileage a cost for motive power of 9·67 pence per 100 ton miles, while for steam the same cost is 4·89 pence, and in this comparison the cost of the electrical generating station was not included.

Mr. Aspinall, while pointing out these facts, does not take a biassed view of matters, and would probably just as soon use electrical as steam motors. At the same time it by no means follows that either comparison cited is very valuable. The crux of the matter in every case must be the cost of motive power per passenger mile, and where electricity helps to keep down this rate it matters little what the ton mile rate may be. A doubling of the two-mile rate would be welcome if accompanied by a threefold reduction of the *tons* and the likelihood is that electricity will reduce the tonnage and increase the passengers per ton of dead load. A critic like Mr. Aspinall is always welcome. He sees the above point though he did not positively bring it forward. More trains at shorter headway is, of course, a likely source of more passengers, but at the same time it increases the working staff and is impossible to work on a line where stopping trains are to be run, for the express or through traffic would be delayed, and the slow trains would be too frequently shunted.

The weight of carriages cannot well be reduced if they are to stand the shocks of high speeds, and of shunting operations, and it certainly seems likely that the future electrical carriage will not be of the light tramcar variety, but that it will approximate to the type of the steam railway carriage. Nor does Mr. Aspinall look forward to the fact that the aggregate weight of all the motors on the carriage axles will be less than the present weight of locomotives. There would be a saving, more especially in *short* bridges, due to the absence of the locomotive or concentrated load.

The nonsense of Messrs. Davis and Williamson about speeds of 170 miles per hour in the same magazine does not seem to appeal to Mr. Aspinall, who looks to a steady advance upon established and conservative lines rather than to any sudden jump into a new future.

THE ENGINEERING DISPUTE.

θεά μ'ἔσφηλεν ἐμβαλουσα λυσσώδη νόσον. In the course of his particular brand of madness Mr. Barnes has succeeded in raising up a combination of capitalists which, as a writer in the *Standard* remarks, he would rather not have seen, as he is opposed to rings and trusts, but the "Federated employers" have been flogged into federation by the outrageous demands of new unionism. Defiant to the last, Barnes has no grace to admit his error in tumbling to ruin the edifice of the old trades unionism in his vain effort to exalt his own reputation by a course of action directly opposed to sound sense and economic reason. The career of Barnes is an illustration of the old adage, "Set a beggar on horse-back and he will ride to the devil." Barnes has ridden to the devil, which seems to the *Engineer* a very natural proceeding for a "young man with some brains, plenty of energy, not a little conceit, &c., and an earnest desire to get himself talked about." Such a man with full control of £350,000 and 87,000 workmen is as little expected to remain at peace as was Napoleon to be expected, after Austerlitz, to go into private life and grow turnips. The *Engineer* seems to blame the system and to excuse Barnes, perhaps on the principle of not hitting a man when he is down. We confess to having no sympathy with Barnes. He might have done so much and he has made a complete fiasco of everything. We have not a grain of sympathy with him. But for the crass folly of the law which does not enforce separation of strike funds and provident funds, where would Barnes be to-day with squandered strike funds? Barnes may think himself lucky. As the *Engineer* remarks, he has had absolute control of the engineering trade of the country and the trade has risen in rebellion. The trade don't want to smash the Union, their business is with Barnes, and Barnes is not unionism, and he has shot his bolt and failed; and the *Engineer* goes on to tell him that if the eight hours were to be granted to-morrow the system of shop work would be all changed, and there would not only be no Barnes to deal with, but Barnes's own men would not obey him. The A.S.E. is in fact undone, and Barnes has undone it. By his ignorance of what true socialism really is, Barnes has raised up a combination of capital and paved the way for a succession of such combinations, which we may all deplore. He has in fact ruined trades unionism as it was and failed to replace it by anything else except capitalism. Barnes has failed in the cause he professed to serve. That he has done so out of pure selfish personal conceit and in the display of such qualities as usually dub a young fellow as a puppy is no ground for extending to him any sympathy now he is down. We doubt very much if he has sufficient of the ordinary perceptions of most men to appreciate either that he is down or that his light entry upon a life and death struggle is of greater importance than drawing his weekly salary. Mr. Barnes is one of that stamp of men who sometimes get into positions where they inevitably upset all they touch. They are hopeless egotists as a rule. We once heard the chairman of one of the railways south of the Thames talking very volubly about people who did not understand railway management. He was alluding to men who manage the Midland and the G. N. Railways, and could not see how the line, ruined by himself, was a reflex of his own powers. So with the new unionists: they have taken positions which are beyond the scope of their intellects, and the natural result has followed, and their places will probably know them no more.

A correspondent of the *Standard* complains that the Press generally has been too lax in permitting the publication of statements which had no real basis of truth. Thus the boasted London list of employers solid for eight hours was soon torn to pieces when investigated, yet it was widely disseminated by the Press to the very serious injury of Mr. Barnes's following, who were encouraged in their ruinous

fight by a piece of gross deception. That the conference has before it a difficult problem no one doubts, though we believe the men themselves would be glad of the simple *status quo ante*, and we are fairly confident, too, that very many of them are sick and tired of the tyranny of restricted output and enforced loafing. At the same time, the question of interference is deeply grafted in the heart of the more ignorant unionist, and will be probably struggled for in some more or less indirect manner. The only way in which machine production can be kept up to the mark in the face of any union attempts to keep it down, is by the pushing forward of the more ambitious labourer and the strenuous protection of good workers against rattening—for we might just as well use this term, though declared obsolete, to describe practices still existent to which the term was originally fitted. What do the men mean when they say they disavow any intention of interfering with management? We all know what employers understand by interference, for they have published a goodly number of typical cases to the world, and declare they will have no more. Mr. Barnes knows that the machine question he once pushed to the front is an unpopular one, for he wrote to the Dundee paper his letter about his good fortune in having shunted the ground of dispute from an unpopular to a popular issue when he brought forward the eight hours as a basis for fight. He meant to have a fight, but he thought by hiding his head in the sand, ostrich like, that he could blind the world to the real issue, and doubtless is quite surprised to find how the fight has rallied round interference more and more as the weeks and the funds of the A.S.E. slipped away.

Engineering has secured a copy of new *Trades Union Journal* which is devoted to the smashing of employers generally, and from its pages our contemporary shows that the A.S.E. in their fight against machinery, have made it a point to keep up the costs of labour on manufactured articles. We have ourselves all along urged that this policy discouraged the use of improved and new tools, and left employers unwilling to change their old tools which can easily be made do all that the newest tools are allowed to do. Now tool making demands a large proportion of skilled workmanship, and the A.S.E. have been striking at the very root of skilled labour in reducing machine output. If they had been able to do the same in Germany, France or America, we could have seen a certain amount of reason in their efforts; but they have not been able to do this, and have forced English trade into a position of very serious disadvantage. Altogether the extracts selected by our contemporary show what is the ideal of the A.S.E., and, if they be socialists, their ideal of socialism. If there is one thing absolutely necessary to secure the success of socialism, it is an absolute all round honesty, and it is exactly in this fundamental necessity that the Barnes gospel fails most lamentably.

LEGAL.

Tayler *v.* Sax.

In the Queen's Bench Division on Friday, before Mr. Justice Channell, an action was brought by a Mr. Tayler, stockbroker, &c., against Mr. Charles Wm. Sax, electrical engineer, to recover money alleged to be due on a commission note given to a third party. Mr. C. A. Russell, Q.C., and Mr. Bailhache appeared for plaintiff, and Mr. Tindal Atkinson, Q.C., and Mr. J. S. Greene for defendant.

Mr. Russell in opening the case said the action was on what was commonly known as a commission note, and the plaintiff was suing as the assignee under an assignment to him by a gentleman named Gomer. The original agreement was contained in a letter of January 23rd, 1896, addressed by defendant to Gomer, and was to the following effect:—"In the event of your getting a transfer of the Lambeth order to the new company and floating the same into a company successfully, I undertake to pay you £500 in shares on consideration of your doing your best to assist me in getting a gentleman to bring forward the project." The Vestry of Lambeth had so long ago as 1892 obtained a provisional electric lighting order, which was fully comfirmed by one of the confirmation Acts. The Vestry was desirous of finding some one to take over the powers contained in the order, and to put them into operation. Defendant, Mr. Sax, was an electrical engineer, and he got into negotiation with the Vestry to obtain from them a transfer of the order, he intending to have a company formed which would take over and work the business. Mr. Gomer was in a position, as Mr. Sax thought, to give him some assistance in the matter, and consequently a bargain was entered into. The defendant said that there was no consideration for the agreement, but he could not see how there could be anything in that contention, because Mr. Gomer did, after the date of the agreement, render certain services, the details of which his Lordship, if necessary, would hear for himself, to Mr. Sax to aid him in carrying out the project. In October, 1896, Mr. Gomer was indebted to the plaintiff, and the latter wanted some sort of security for the indebtedness, which it was contemplated would be an increasing indebtedness. Mr. Gomer then mentioned to the plaintiff the fact of his having the commission note, and in the following month of November the plaintiff, wishing to be assured that the note was in order, communicated directly with the defendant, asking him to confirm it. Ultimately, on November 24th, a reply was received, which said:—"I have now seen Mr. Gomer, and have pleasure in confirming the letter I gave him promising him 500 shares as soon as the company is floated." Gomer had done what he could in the way of getting defendant into connection with persons who would aid him in carrying out the project, and defendant had seen them and discussed terms with them. He believed that, as regarded plaintiff's position up to November 24th, it was that he had advanced to Mr. Gomer about £250, substantially on the faith of that commission note, which was then deposited with him. He advanced further sums, which brought the amount up to the time of the formal assignment to £483 odd. On December 4th, 1896, a company styled the South Lambeth Electricity Supply Corporation, Limited, was registered, and by the memorandum of association of that company it appears that its first object was to obtain, by purchase, the Lambeth Electric Lighting Order of 1892.

Mr. Tindal Atkinson: I submit that that cannot bind my client. It was without his authority or knowledge.

Mr. Russell: I submit I am entitled to put in this memorandum as one of the steps in the case, as showing that what was contemplated by the bargain was fulfilled. He then read the memorandum, which stated that the company was formed to take over the Lambeth Electric Lighting Order, which was the order referred to in the agreement, and which showed the interest the defendant had in the transaction. That was on December 4th, within a few days of the letter written to the plaintiff by the defendant, confirming the bargain with Gomer. That showed that he knew perfectly well that there was an electric light company at Lambeth which was on the point of being promoted. On March 16th, 1897, that company obtained from the Lambeth Vestry the formal transfer of the provisional order, subject to the sanction of the Board of Trade. On August 26th, 1896, it seemed that the defendant had entered into an agreement with Mr. Jacob Atherton for the promotion, by Mr. Atherton, of a company, to be called the South London Electric Lighting and Power Company, Limited, or such other name as might be chosen to take over from the Lambeth Vestry the order of 1892, and the company which did finally take over the electric lighting order was promoted by Mr. Atherton, with whom Mr. Sax, the defendant, had made an agreement that such a company should be promoted. The company was not only formed, but went to allotment; it had obtained a settlement on the Stock Exchange, and its £2 shares were now quoted at about par. He submitted that that was a company which had been floated by the defendant within the meaning of the bargain upon which the plaintiff sued, and under which defendant agreed to pay him £500 as soon as a company had been successfully floated.

His Lordship: You have not told us what the defendant got out of it.

Mr. Russell: I don't know. He made a bargain with Mr. Atherton that the latter should promote a company to take over this electric lighting order. I am not in a position to say what Sax got. It is for him to disprove what I have stated.

His Lordship said it was for Mr. Tindal Atkinson to show that the agreement which had been signed by defendant had not been carried out.

Mr. Tindal Atkinson, for the defendant, said his case was that sometime in 1886 his client applied to the Vestry of Lambeth to to transfer the order to him. His application was referred to the Board of Trade, and in the meantime he wrote the letter to the plaintiff, as he wished to find some one in the shape of a financier to assist him in forming it into a company. His client thought he should get the order sanctioned by the Board of Trade, but it was refused. Then, independently altogether of the plaintiff, he got into communication with Mr. Atherton. The original company was formed for the purpose of taking over the order. Whilst those negotiations were going on they got into communication with Tayler, who was a stock jobber. Mr. Gomer was a customer of his, and there was no doubt he wanted security for the indebtedness. Ultimately Mr. Gomer saw his client, and pressed him very hard to confirm the arrangement in order to get him out of his difficulty. What happened was that the Board of Trade refused its sanction to the transfer, and that put an end to the entire thing, which fell through like a house of cards.

His Lordship: Although they did not sanction the transfer to you, they did sanction it to what was practically your nomination.

Mr. Tindal Atkinson said that in the company which was ultimately formed, his client was not interested to the extent of a single share or a single shilling. If he could prove that that was so, the action came to an end.

Mr. Chas. Wm. Sax was then called, and said he was an electrical engineer, and lived at 2, Golden Square. In January, 1896, he made application for the transfer of the provisional order from the Lambeth Vestry to himself. The Vestry agreed, subject to the sanction of the Board of Trade. He had to pay the expenses of the Vestry in the application, £1,000, and deposit £5,000 as security for carrying out the contract. The Board of Trade refused to grant the transfer. He was introduced by Mr. Gomer to a firm of financial agents. Another company was subsequently formed, but he had not a single share in it, and he had had no part of the consideration mentioned in his agreement of January 26th, 1896.

Cross-examined by Mr. Russell: The Vestry told him that the Board of Trade had refused their sanction, and that they could go no further with him.

You had associated yourself with Mr. Atherton when you contemplated getting it for yourself, in order that he might aid in the promotion of the company?—Yes.

And was the South London Electric Supply Corporation, Limited, the company promoted by him for the purpose of taking over the Lambeth Lighting Order?—It was.

You knew of the promotion and formation of that company?—Yes.

Was it formed to take over the lighting order and your interest in it?—I was told before that company was formed that the Board of Trade would not allow me to have any interest in it.

Did you know at the time you wrote confirming your promise of

500 shares that the New South London Electric Supply Corporation was on the eve of being registered?—Yes, I did.

You knew that Mr. Atherton acted as promoter of that company. Did he get a large sum through forming the company?—He told me he got very little out of it.

Did he not, as a matter of fact, get £43,000?—I do not know.

Have you not received anything from Atherton directly or indirectly?—No. We were not on friendly terms.

When did your friendship cease?—When I lost my interest in the company. Our friendship became strained. I had no communication with Atherton after the Board of Trade refused to sanction the transfer to me. I went abroad to Madeira in March.

Had you given any commission notes to anybody besides Gomer in anticipation of the formation of the company?—Yes.

Did you give into the hands of Mr. Vendershing the settlement of the claims of these persons against you?—I did.

And did you tell Mr. Vendershing to tell them that you had not got as much as you expected from the company?—No. I said I had lost money over it, because I had to pay all the expenses and did not make anything.

Did he not tell the plaintiff that you had not made as much out of it as you expected?—I don't know what he told the plaintiff.

Is it not a fact that you made something out of it, but not as much as you expected?—I have not got a penny piece yet. I have been promised an honorarium by one of the contractors for introducing him to some work, but I have not got a penny piece yet.

What are you promised?—He promised me a present for introducing the dust destructor part of the scheme to him.

Have you made any claim on Atherton?—No. I have not asked him for anything.

You have had a good deal to do with the formation of companies?—No. This is the first company I have tried to form.

In further cross-examination defendant said he had instructed his solicitors to write for the transfer of provisional orders to York, St. Mary's parish, Lambeth, and Fleetwood, but company promoting was not his business.

Re-examined: He had nothing to do with the registration of the company of December 4th, 1895. Mr. Vandershing was his father-in-law. All he had got out of the whole thing was a promise by a contractor to whom he introduced the destructor scheme.

His Lordship gave judgment for the defendant, with costs, and ordered a sum of money paid into Court to be returned.

Nicholson & Tyler v. Lawrence.

In the Official Referee's Court on Friday, the 12th inst., before Mr. Verey, the further hearing was resumed of the action in which Messrs. Nicholson and Tyler, electrical engineers and contractors, sued Mr. Joseph Lawrence, of Oaklands, Kenley, Surrey, chairman of the Linotype Company, to recover the sum of £205 5s. 6d. for balance of account for an installation of electric light at defendant's private residence. The evidence on behalf of the defendant was completed, and after Mr. Noad (instructed by Mr. P. C. Shaw) and Mr. Rufus D. Isaacs (instructed by Mr. Frederic Hudson) had addressed the Court, the Referee gave his judgment. He held that by the contract the plaintiffs were bound to provide an installation as therein specified. As to the question of the high efficiency lamps, Mr. Charrington and Mr. Addenbrooke thought that reasonable care had been used, and that there was no fault on the part of the plaintiffs. The defendant's experts differed, but the Referee found that there was no evidence that the plaintiffs were wanting in skill, even assuming that they had to use their skill as electrical engineers, and not merely as contractors. He was satisfied that the installation and accumulators would do the work they were originally specified to do, and that the extra accumulator and work were ordered by the defendant. As regards the other items, the only evidence that had been given on behalf of the defendant was that of Mr. Timmis, whose opinion seemed entirely to rest on the information supplied to him by Mr. Lawrence. Under these circumstance he found for the plaintiffs for the full amount claimed, with costs on the claim, and also for the plaintiffs on the counterclaim, with costs. Judgment was entered accordingly.

A Supervision Order.

On Wednesday, in the Queen's Bench Division, before Mr. Justice Wright, sitting as an additional judge of the Chancery Division for the winding-up of public companies, in the matter of New & Mayne, Limited, which is being voluntarily wound up, application was made, on the petition of J. K. & R. Lord and others, for a supervision order. There was no opposition, and his Lordship granted the application.

BUSINESS NOTICES, &c.

Accumulators in Belgium.—A new company has just been formed in Brussels, with a capital of £40,000, with the title of La Société de l'Accumulateur Sec.

Agency Announcement.—The Fowler-Waring Cables Company, Limited, have appointed Mr. H. F. Harris, 40, Merrion Avenue, Blackrock, Dublin, as their agent in Ireland for the supply of all types of both lead-covered and rubber-covered electric light and tramway cables.

Electrical Wares Exported.

Week Ending Nov. 16th, 1896.	£	s.
Amsterdam	40	0
Antwerp	46	0
Auckland	450	0
Bombay	100	0
„ Teleg. wire ...	27	0
Buenos Ayres	895	0
„ Teleg. mat.	132	0
Calcutta	275	0
Cape Town	300	0
Christiana. Teleg. mat.	50	0
Colombo	50	0
Copenhagen. Teleg. mat.	80	0
Durban	311	0
Dusseldorf. Teleg. mat.	129	0
Flushing	7	0
Gothenburg	23	0
Hamburg	179	0
Launceston	150	0
Lisbon. Teleg. mat. ...	52	0
Melbourne	102	0
Ostend	10	0
Passages	770	0
Rosario. Teleg. mat....	205	0
Santos. „ ...	628	0
Singapore	17	0
Stockholm	14	0
„ Teleg. mat....	361	0
Suez. Teleg. mat. ...	78	0
Sydney	1,727	0
Townsville	150	0
Vancouver, B.C. ...	22	0
Yokohama	250	0
Total	£7,571	0

Week Ending Nov. 16th, 1897.	£	s.
Adelaide	21	0
Albany	185	0
Alexandria	220	0
Amsterdam	45	0
Antwerp	88	0
Barcelona	10	0
Bombay	46	0
Buenos Ayres Teleg. mat.	181	0
Calcutta	213	0
Cape Town	584	0
Colombo	44	0
Durban	32	0
„ Teleg. mat. ...	259	0
East London	157	0
Flushing	98	0
Genoa	767	0
Gibraltar	151	0
Gothenburg	197	0
Lisbon	67	0
Madras	443	0
Malta	79	0
Mauritius. Telephone...	160	0
Melbourne	158	0
Novorossisk	8	0
Passages	88	0
Port Elizabeth	303	0
„ Teleg. mat.	130	0
Rio Janeiro	850	0
Santos	26	0
„ Teleg. mat. ...	22	0
St. Petersburg	15	0
Sydney	1,636	0
„ Teleg. mat. ...	23	0
Stockholm	960	0
„ Teleg. wire	249	0
Yokohama	420	0
Total	£8,276	0

Amalgamation.—In consequence of increased trade the two old established businesses of H. Binko & Co. and Ridsdale & Co., carried on at 34, Leadenhall Street, E.C., and 54 and 120, Minories, E., have been combined and formed into a limited company under the style of Binko, Ridsdale & Co. There will be no difference in the conduct of the two businesses, the management remaining the same. The capital is fully subscribed by the present owners and their friends.

Ball, Wylde & Co.—Messrs. Ball, Wylde & Co. have commenced business at 9 and 10, Fenchurch Street, London, as importers and exporters of electrical goods of all kinds, and as agents for both home and foreign manufacturers.

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court, held on the 12th inst. before Mr. Registrar Hope, Frederick Griffin applied to pass his public examination upon accounts showing liabilities £1,850, ranking against assets £154, subject to preferential claims, £87. In the course of his evidence, the debtor stated that in January, 1895, he entered into partnership with another person at 26½, Clarges Street, W., for the purpose of exploiting a patent electrical accumulator, which was financed to the extent of £300 by a syndicate, with a view ultimately of forming the same into a limited company. The undertaking was unsuccessful, and in January, 1896, the partnership was dissolved, the patent being taken over by the partner, who, in the event of success, was to recoup the syndicate. The examination was ordered to be concluded.

Dissolution of Partnerships.—Messrs. A. J. Harrison, E. C. Pringle, and W. C. Middleton, hitherto trading under the name of Harrison, Coles & Co., electricians, at Hermitage Electrical Works, Richmond, and other places, have dissolved partnership as from August 24th, 1897. The business will be carried on under the same name by A. J. Harrison and E. C. Pringle.

Messrs. W. H. Johnstone, W. Sutton, and S. Lord, carrying on business as electricians at 16, Redcross Street, Liverpool, under the title of the Howe Electrical Engineering Company, have dissolved partnership so far as concerns W. H. Johnstone. The two other partners will continue the business under the old style, and will attend to debts.

Liquidation Notice.—At a meeting of the I.E.S. Accumulator Company, held at 9, Bridge Street, Westminster, on October 26th, it was resolved to wind up the company voluntarily, Mr. D. F. Basden (of Mellors, Basden & Co.), of 33, St. Swithin's Lane, E.C., being appointed liquidator.

Catalogues.—From Messrs. L. M. Ericsson & Co., of Stockholm, we have received a copy of the fourth edition of their catalogue of 120 pages bound in stiff brown cards. The book, which is excellently illustrated and for which a good glazed paper is used, describes the firm's various telephonic instruments and accessories, in three languages, including English and French. The following are some of the apparatus, &c., described in the catalogue:—Telephonic plant, including sets for terminal stations, telephones for intermediate stations on metallic circuits, portable sets, table, wall, and extension sets, junction switches, wall switches and generators, testing sets, breastplate transmitter with head gear receiver, transmitters,

receivers, and switchboards. The other sections deal with telegraphic plant, testing instruments (resistance boxes, Wheatstone bridges, and galvanometers), fire alarm apparatus, and sundries.

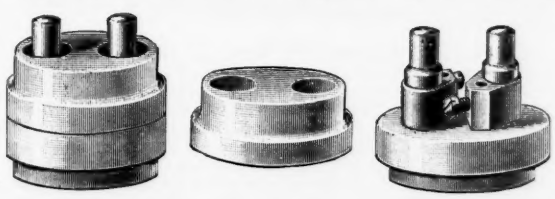
Messrs. O. Berend & Co., Ltd., have brought out a new trade price list. In the switch section there are numerous diagrams and other illustrations, showing the action of the various single and double pole main and branch switches made by this firm, the K.H.O. standard main switch having a large amount of space devoted to it. The K.H.O. automatic switches or cut-outs, two-way and change-over switches, multiple contact accumulator regulators are described at length, diagrams of connections appearing in some cases. Various types of resistances and regulators are included, tabulated details being given also prices. In addition there are various other appliances and accessories for electric lighting and power work described.

Electrical Work in Australia.—Messrs. H. H. Kingsbury & Co., of Margaret Street, Sydney, have been appointed sole agents there for the General Electric Company of America.

Gas.—A serious gas explosion occurred at the Steam Packet Inn, Middlesbrough, on 11th inst., damaging the premises and injuring three persons.

Guildford.—The Town Council has decided to replace the present modern clock dials (which are opaque glass, and are illuminated from the inside by means of eight gas lights), with the original dials. These are very ancient, and have a solid copper framework, which is to be gilt-relieved. The lighting will now be by means of electricity from the outside of the clock face. Four powerful lights will be placed on each side of the dials. These will be controlled from switches in the Town Hall. Messrs. H. Fentum Phillips & Co., of Guildford Electrical Works, are carrying out the work.

Improved Insulation of Lamp Holder Terminals.—If the wiring of a lamp holder is done carefully there is probably not much danger of a short circuit, but ordinary lamp holders do not provide against careless work, and if the ends of the wires are not screwed securely home it is not a matter of extreme difficulty to provide a path from one terminal to another. The introduction of high voltage lamps has intensified this danger, and any means that will



prevent such an occurrence is of great importance at the present moment. To avoid all possibility of accidental contact being made between the terminals, Messrs. Williamson and Joseph have devised a porcelain collar which fits closely over them. The collar is divided into two compartments, the terminals being thus effectually separated from one another. The arrangement is clearly shown in the annexed illustrations.

New Branch.—The General Electric Company, of London and Manchester, have added another branch to their business, situated in Dublin. The branch is under the management of Mr. Fletcher, who has had some years' experience with the company in London. Premises have been taken at 9, William Street, Dublin, where a good stock will be kept.

New Lamp.—We hear that the Edison & Swan Company are about to place on the market a new lamp, the chief feature of which is that it is capable of being run at a very high efficiency. We are informed that on circuits, when the pressure is steady, an economy of at least 25 per cent. can be effected by the use of the new Ediswan lamp.

Personal.—Mr. W. Everett Gibson is now with the British Blahnik Arc Light Company, of Parliament Street and Victoria Street.

The "Brillié" Meter.—Messrs. Downie & Adams, of 24, Newman Street, Oxford Street, W., have acquired the patents for the sale and manufacture of this meter throughout the British Empire. We understand that the meter is very largely used on the Continent. The firm has issued a descriptive pamphlet, in which it is described in detail by means of letterpress and diagrams. The construction and working of the apparatus are explained very exhaustively; and the constituent parts of the meter are shown by the aid of lettered illustrations. The advantages, method of adjustment, and setting precautions to be taken, are stated, and a great deal of other information is given. Among special points claimed for the meter is the simplicity of adjustment, sensitiveness, and economy in use.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Harbour Board is taking steps to light the docks electrically, current to be taken from the municipal mains. The estimated annual cost is £1,700, but the Council will pay £250 per annum of this for lighting the pavements.

Bedford.—The Council has accepted the tender of Messrs. Cory & Sons, Limited, for the supply of Stanton hard steam coal for the electricity works at 12s. 5d. per ton, until June 1st, 1898. The Local Government Board has sanctioned the £19,650 electric lighting loan.

Blairgowrie.—Particulars are being collected regarding telephones and electric lighting for the Police Commission. Mr. R. F. Yorke has sent particulars of several Scotch installations.

Brechin.—The Police Commission last week signed the agreement with Edmundson's Electricity Corporation for the introduction of electric lighting.

Camberwell.—At the fortnightly meeting of this Vestry, held on Wednesday evening, the General Purposes Committee announced that they had had under consideration a statutory notice from the London Electric Supply Corporation of intention to lay mains in the Camberwell Road. In this connection the committee submitted a long report prepared by Mr. C. William Tagg, Clerk to the Vestry, dealing with the question. In commenting upon this report the General Purposes Committee recommended the Vestry to ask the Board of Trade to refuse consent to the laying of the mains, and to revoke the provisional order in pursuance of Section 25 of the order.

Cambridge.—The pumping station of the Council is to be lighted electrically at a cost of about £181.

Cardiff.—At the last meeting of the Electrical Committee the electrical engineer reported that there was a failure in the electric supply about six o'clock on Sunday evening last. The fault was found about 8.30. It was a short circuit on No. 2 feeder in a junction box at the corner of Wood Street and St. Mary Street. The heat of the arc also considerably damaged an adjacent cable (the one supplied by Messrs. Siemens last year). The original fault was repaired by about 12.45 a.m. on Monday. The effect of the fault on the lighting was to extinguish all lights for a few minutes until the electrician-in-charge could see which feeder had broken down when it was disconnected.

Chelsea.—There was a long discussion *re* electric lighting at last week's vestry meeting *re* the application of the County of London and Brush Company for sanction to their proposed provisional order, the report of the surveyor—to which we have already referred—being also brought into the discussion. The Lighting Committee is to look after the matter.

Cheltenham.—On Thursday last week, a Local Government Board Inquiry was held respecting the £18,385 electric lighting extensions loan. The Deputy Mayor (Alderman Norman) gave particulars of the undertaking showing its progress, and explained that customers were waiting to be connected to the mains. Mr. Kilgour, the electrical engineer, also gave evidence showing that the Council had been obliged, in order to meet the demands for the winter, to incur beforehand the liability for practically the whole sum mentioned, by ordering additional machinery.

Colchester.—The Electric Light Works Committee reported to the last Council meeting that having considered the contract for the erection of station buildings, and a proposed addition by the contractors, they had resolved that the deed must be entered into as originally drawn. Having considered the correspondence as to the draft contract by the Electric Construction Company, Limited, for the establishment of works, &c, and it having been ascertained that the assumption that the company now decline to undertake the works was correct, the committee had considered a communication from Messrs. Siemens Bros., Limited. This stated that Messrs. Siemens now found that by deducting the estimated cost of street work and modifying the engines and dynamos as suggested by Mr. Massey, the amount of their original tender could be reduced to about £10,800. They would be willing to carry on the work now on the terms of the draft memorandum of agreement, provided the necessary guarantees could be arranged with the engine makers. They were prepared to hand over to the Corporation one-half of the net profits of the first two years' working, provided that in the improbable event of their being any loss they should be repaid the amount out of the first profits made by the Corporation after they had taken the running of the electric light works into their own hands. The committee now unanimously recommended that as the Electric Construction Company had declined to undertake the works unless a general arbitration clause was inserted in the contract deed, the Council accept Messrs. Siemens's offer, the amount of their reduced tender being only £34 13s. in excess of that of the Electric Construction Company, and that the contract with Messrs. Siemens be sealed accordingly. After considerable discussion the report was adopted.

Crieff.—Mr. W. Arnot (late borough electrical engineer of Glasgow) has been reporting to the Crieff Town Council on the advisability of utilising the water power of the Barvick and Turret Falls (three miles to the north-west of Crieff) for the purposes of electric lighting of the town. Mr. Arnot says that to utilise these falls, it would be necessary to form a large reservoir near the Barvick, and the cost of this and other necessary works would be £8,000, the working expense annually being £1,418. Mr. Arnot thinks the safest and the cheapest way to light Crieff with electricity would be to do so by steam power. This would cost £6,000, with £1,275 per annum as working expenses.

Deal.—The Town Council has received an offer from an electrical engineer to prepare a preliminary report on electric lighting.

Dingwall.—The Town Council has agreed to have the public streets lit with electric light at a cost of £102 10s. per annum, for nine months during the year.

Dover.—At the last Council meeting Councillor Chitty complained that it had been left to the surveyor to make the deductions in the electric lighting bill for lamps being out, instead of the company making the requisite deductions and leaving it to the surveyor to check them. The Town Clerk pointed out that the deduction was in the nature of a fine on the electricity company, and therefore it must be left to the surveyor as the company could not be expected to fine themselves.

Dublin.—In connection with the Corporation's electric lighting scheme, Prof. Kennedy has reported that the Pigeon House Fort site is not at all suitable for the proposed electrical station. It is proposed to ask him to furnish a supplemental report, suggesting the best site for the purpose.

The postal authorities are about to provide an independent electric supply for their Dublin offices.

Eccles.—At a recent Town Council meeting a letter was read from the Edison and Swan Company, Limited, stating that in consequence of their giving up the undertaking of complete contracts such as the Eccles contract, and of the increase in the price of electrical plant, they are not now prepared to undertake the contract for the electric lighting in this borough on the terms of their tender. The letter was referred to the Electric Lighting Committee. The tender of Mr. George Macfarlane to erect the electric lighting station for the sum of £1,990 was approved by the Council.

Enfield.—The Hospital Committee of the District Council is looking into the question of lighting the new isolation hospital by electricity.

Hammersmith.—Both high and low tension mains are to be laid through Great Church Lane and Colet Gardens to a transformer station constructed in the Hammersmith Road, at an estimated cost of £820. Mr. Preece is to prepare specification and estimate of the cost of plant, mains, &c., for completing the lighting of three main roads.

Hanley.—An engine-driver in the electricity works was found lying in the bottom of the engine wheel pit severely injured, a few days ago. He has since died.

Hornsey.—At the Hornsey District Council meeting on Monday evening, the adoption of a report of the Electric Lighting Committee, in which a scheme for lighting the district by electricity was brought up, was agreed to. The Committee's report contained lengthy statements and reports by Mr. E. J. Lovegrove, C.E., and Mr. R. Hammond, M.I.E.E. In the former the writer recommended that a small area only should be included in the application for a provisional order, and that the best system to adopt was the high pressure alternating current, and the most suitable place for the central station would be the Sanitary Depôt at Hornsey, and it might be possible to use the spare heat from the dust destructor at this depôt. Upon this Mr. Lovegrove remarks that the house refuse in Hornsey was "of the poorest possible description, and during the summer months it is with difficulty that the furnaces are kept alight." The heat produced was about 800° F. at outlet of main flue to boilers, and the steam raised at times was not sufficient for the present machinery, which consists of a mortar mill, sawing, drilling and turning machinery, and paving machinery which was now about to be fixed. It would be desirable to provide in the compulsory area 6,000 8-candle-power lamps for private and public buildings, and 45 2,000-candle-power arc lights for the scheduled streets. The machinery should not be less than 300 kilowatts or 10,000 8-candle-power lights, which would be equal to 15,000 8-candle-power lights on consumers' premises. The cost would be about £30,000. To meet contingencies the Committee inserted £35,000. Mr. Robert Hammond, after referring to the difficulties of the district for electric light purposes, says with reference to the dust destructor: "My experience leads me to believe that too much reliance cannot be placed upon the source of power derived from a dust destructor." He recommends the Council to lay down a reasonably large plant in duplicate. He suggested that the £30,000 should be increased to £35,000, and concludes by stating that "for this figure an installation could be obtained with sufficient generating plant and mains distribution to deal with the number of lights which would yield a revenue of 6d. per unit; sufficient to cover the cost of working and the interest and sinking fund. My estimate also covers the provision of buildings of a substantial nature of a size adapted for the permanent installation by easy extensions."

Leatherhead.—The Council is proceeding with its electric lighting order application. Two electrical engineers have asked to be employed, but these applications are considered premature.

Leeds.—A Parliamentary sub-committee is looking after the interests of the city in regard to the Bill to be introduced for the construction of the proposed light railway between Leeds and Bradford. A special meeting of the Parliamentary Committee is to consider the suggested purchase of the Yorkshire House-to-House Electricity Company's undertaking.

Lewes.—With reference to our last week's note, we understand that the Corporation further instructed Mr. Warden-Stevens to prepare estimates (which have now been completed) for an alternative area of supply for the Borough lighting scheme.

Lowestoft.—The Town Council will hold a special meeting on the 30th inst. to consider the question of applying for a provisional order for the lighting of the town by electricity.

Maidenhead.—It has been decided that High Street and Queen Street shall be the compulsory area under the electric lighting order to be applied for.

Merthyr.—It is stated that the provisional order obtained by Mr. J. C. Howell, Llanelly, is not likely to be in abeyance much longer, as steps are now being taken to carry out the work.

Middleton, Lancashire.—Mr. S. V. Clirehugh is to prepare a report for the electric lighting of the above borough for the Council.

Mitchelstown.—A Local Government Board inquiry was held here on 6th inst. into "the question of fixing the chargeability for a scheme for the public lighting of Mitchelstown promoted by the guardians under the Electric Light Act, 1882." The *Irish Independent* says that the Mitchelstown Board of Guardians are the first Irish Poor Law body to take advantage of the Act, and the inquiry was the first of its kind in Ireland.

Musselburgh.—The Gas Company charges 3s 9d. per 1,000 and declares a dividend of 10 per cent. An electric lighting committee is being formed to supply the district, and it is proposed to utilise water power from the mill-lade.

Oldbury.—Mr. F. J. Warden-Stevens has been retained by the Council as consulting engineer in connection with an electric lighting and power supply scheme for the district. The Council owns the gasworks, and the site suggested for the electricity supply works adjoins these.

Perthshire. — The Blackford Brewery of Mr. W. B. Thomson is now lighted electrically, the installation being put in by Messrs. Jas. Maxwell & Son, of Dundee. There are over 100 incandescents and one 2,000-C.P. arc.

Plymouth. — The engineers' strike is stated to be responsible for delay in completing the electric light undertaking, but it is anticipated that the works will be in operation within 12 months.

The chairmen of committees having new buildings in course of erection, were asked at last week's Council meeting to consider the advisability of lighting them by electricity.

Provisional Orders.— The *London Gazette* for Friday last contains copies of applications which are being made for provisional orders for municipal electric lighting for the following districts:—Ossett, Willesden, Aldershot, St. Albans.

Westgate-on-Sea, East Stonehouse, Rotherham, Weymouth and Melcombe Regis, Chorley, Colne, Rawmarsh, Doncaster and Stourbridge electric lighting order notices appear in the *London Gazette* for Tuesday 16th inst. In the same publication are particulars of tramway powers sought for Halifax, East Ham, and Oxford and district.

Smethwick.—The Council has appointed Mr. Warden-Stevens to advise them in connection with an electricity supply scheme for the district, and to render technical assistance in obtaining the provisional order. The gasworks are owned by the Council, and it is considering the erection of a refuse destructor.

St. Anne's-on-Sea.—The Urban District Council has requested Mr. S. V. Clirehugh to prepare a report on the question of electric lighting, &c.

St. Helen's.—The electric light has been introduced into St. Helen's Congregational Church.

St. Pancras.—Mr. Sydney Baynes, the Vestry's electrical engineer, has been having a rather warm time recently with the Finance Committee. It seems that the arc lamp columns were painted at a cost of about £100, but exception was taken to the sum by several members of the Finance Committee, and as something had been said about the quality of the work done, and as to the manner of carrying out the job, the Committee had the contractor up before it, and afterwards called Mr. Baynes' attention to the matter. Mr. Baynes' reply was very much to the point and very emphatic. He considered that to require the contractor to burn off the paint, which is the result of years of accumulation, and never before insisted upon in any other contract, for the nominal sum of 1s. 2½d. per post, would, he submitted, amount to sharp practice, and border on dishonesty. Any such work would, of necessity, be required to be paid for as an extra. He suggested that the action of the committee in dealing direct with the contractor was a breach of etiquette against the Electricity and Public Lighting Committee. The Finance Committee expressed their dissatisfaction with the letter forwarded by Mr. Baynes, which they consider to be an insult to the members of the committee. They thought the Vestry would be of opinion that the letter was an improper one for an official to write. The situation will be of interest to borough electrical engineers all over the country, as we believe that many of them would be considerably relieved if they could occasionally speak their mind without fear of incurring displeasure. When the matter came before the Vestry there was considerable discussion thereupon, and we are pleased to find that Mr. Baynes was supported by Mr. Bernard Shaw, the well-known dramatist, and other members of the Vestry. Mr. Shaw considered that in Mr. Baynes' communication there was nothing which might not properly be addressed by one man to another. He hoped that they would not discourage their officers from speaking their minds. We understand that the report of the Finance Committee was made the subject of two divisions. The voting being equal the matter fell through.

Mr. Baynes has submitted a report as to the extension of the electric lighting to the Hampstead boundaries of the parish. He proposes that the arc lamps should be placed on alternate circuits, to allow of half being extinguished at midnight. This involves greater complication, and about double the mileage of arc mains; but it secures the advantage of economy in light, and should a circuit fail, only every alternate lamp would be extinguished. The matter was adjourned to the next meeting.

Tipton.—We understand that representatives of the Midland Electric Corporation for Power Distribution, Limited, attended at the meeting of the Tipton District Council on 9th inst., and explained the scheme for supplying electric power for manufacturers in the district and for public and private lighting. The company's representatives were Mr. Albright (chairman), Mr. Lowe (secretary), and Mr. Addenbrooke (engineer). The Council deferred the matter until the time arrives for lodging objections with the Board of Trade, and in the meantime the views of other local authorities will be obtained.

Walsall.—The electrical engineer has reported upon the extensions required for the electricity undertaking during next year. The plant is now taxed to its full capacity, and applications are still coming in. It was recommended that additional plant and cables be ordered to the tune of £7,000, and application be made for a loan. The Town Council has adopted the proposals.

West Bromwich.—The Council on 15th inst. discussed the matter of electric lighting and decided to apply for a provisional order. The scheme is estimated at £20,000, and the streets to be lighted have been decided upon.

Westgate.—The parishioners of Westgate have decided to adopt the scheme of electric lighting propounded by the Parochial Committee, which was outlined by Mr. Hawtayne, and a provisional order will be applied for in due course.

Weston-super-Mare.—At last week's Council meeting, a resolution to rescind the resolution passed in October adopting Mr. Hawtayne's electric lighting scheme, was rejected by 10 votes to 8.

Whitechapel.—The electric lighting question has been again raised at the district board meeting, the County of London and Brush Company having intimated that they will apply for a provisional order during next session. The electric lighting committee will consider the matter, and will also go into the question of dust destructors.

Wimbledon.—The Council has decided that the commission of the consulting electrical engineer (Mr. A. H. Preece) shall be 5 per cent. upon the cost of the works carried out under his supervision. The Electric Lighting Committee has been conferring with him regarding preliminary plans, &c. Electric mains are to be laid in eleven private streets now about to be made up by the Council.

Withington and District.—The Withington District Council has instructed the Parliamentary Committee to report to an early meeting of the Council what steps they recommend should be taken with a view to the introduction of electric lighting in Withington, Chorlton, Didsbury, and Walley Range.

Wolverhampton.—The total number of private lamps connected on October 31st was 12,248 (8-C.P. equivalent), being an increase of 3,393, or 28 per cent., over October, 1896. The number of consumers has increased in the same period from 125 to 187, or an increase of 49 per cent. The consumers are chiefly tradesmen, and during the past few weeks the department has been exceedingly busy connecting new consumers and extending the installations of other consumers.

With reference to our note last week *re* the Mayoral Ball, Mr. Harman Lewis, the Borough Electrical Engineer, informs us that the illumination was by electricity derived from the Corporation supply mains. The Walsall Company carried out the installation only.

Workhouse Lighting.—Messrs. Clirehugh & Leigh, consulting electrical engineers, are preparing a scheme for the electric lighting of the Rochdale Union. The same firm have in hand the lighting of the Upton Asylum for the Cheshire County Council, the Cottage Homes for the Chorlton, Manchester, Board of Guardians, the Whittingham Asylum for the Lancashire County Council, &c.

Yarmouth.—The monthly financial statement relative to the electric lighting supply, shows that the income was £411 5s, while the expenditure for production was £203 11s. 2d. The cost of capital and sundry charges amount to £190 per month. Messrs. W. J. Crampton & Co., have submitted a scheme under which the Corporation might carry out the work of wiring and fitting up houses, shops, works, offices, &c., under an agreement with them. The Town Clerk was directed to convene a special meeting to consider this. The committee has decided not to provide motors and other plant on hire at present, as the length of time allowed for repayment of loans was too short to permit of a sufficient return to warrant outlay for such an undertaking.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Tramways Committee has approved the draft order to be presented to Parliament authorising the Corporation to purchase and acquire the tramway system owned by the Aberdeen District Tramways Company.

Brighton.—At the last meeting of the Hove Commissioners, the Legal and Parliamentary Committee reported the receipt of a letter from the secretary of the British Electric Traction Company, Limited, stating that they proposed to promote a scheme of electrical tramways in Brighton, one of the schemes being a tramway which would pass through part of a road within the town of Hove; intimating also that they were promoting these tramways under the Light Railways Act. The committee recommended the Council to write to the Commissioners of Light Railways, stating that they strongly objected to it, and also that they should instruct the Town Clerk and solicitors to take all such steps as might be considered advisable, including the retention of agents and counsel, to oppose the proposed application to the Light Railway Commissioners. It was stated that the Brighton Corporation were as much opposed to the scheme as Hove. The committee's recommendations were adopted.

Cardiff.—The *Western Mail* last week published a plan of the thoroughfares through which it is proposed to run municipal electric tramways.

Dublin.—The electric tramcar service from Annesley Bridge to Dollymount was inaugurated on 11th inst.

The Corporation had before it last week correspondence respecting the tramway service, and a formal resolution was passed consenting to the construction of certain lines within the city by the Tramway Company.

Folkestone.—The Sandgate District Council has resolved to support the electric tramway scheme on certain conditions.

Huddersfield—Last Friday's *London Gazette* contains a copy of application being made by the Huddersfield Corporation for a provisional order for the construction and operation of tramways in the borough. There are the usual clauses in the order respecting the haulage power, horse and all descriptions of mechanical power being mentioned.

Italy.—An electric tramway is about to be constructed between Massa and Carrara. The water-power of the Magra River is to be utilised at the power station.

Kinver.—The Kingswinford Rural District Council, and the Stourbridge Main Drainage Board, have decided to give the promoters of the light railway to Kinver their support, and every facility possible, for the construction of the scheme.

Leeds.—The *Leeds Mercury* says that on 15th inst. there was a 25 minutes' suspension on the electric tramway service, the cause being "an interruption in the supply of the current."

Light Railways.—The promoters and supporters of the proposed light railway from Oswestry to Llangynog, by way of Tanat Valley, for which an order has been issued by the Light Railway Commissioners, is being well supported by the various local authorities of the districts to be traversed, £16,500 being promised in this way. £8,900 has been subscribed privately, and a Treasury grant is anticipated.

A scheme is on foot for constructing a light railway from Aberystwyth to Aberayon.

Penarth and Cardiff.—The Penarth District Council has submitted to a Sub-Committee to go into the clauses of the above light railway Bill.

Sheffield.—The City Council had the electric tramway contracts before it last week, the Tramways Committee minutes leading to the discussion. Alderman Clegg, the chairman, explained that the Committee desired to withdraw the minutes relating to the tenders of Messrs. Siemens Brothers, and the British Thomson-Houston Company, for the line from Nether Edge to Tinsley, as it had been somewhat overlooked that it was undesirable to have two sets of contracts. The question of dual responsibility might arise, against which the Committee were desirous of safeguarding. Mr. Fisher said although the Committee had withdrawn the paragraphs in regard to the contracts, he believed it was still their intention to give this important piece of work to firms outside Sheffield, and a definite pronouncement of opinion might be useful at this time. Inquiry, he said, had elicited the fact that the reason why Davy Brothers—with whom there would have been no dual responsibility, as they agreed to accept the entire responsibility for the work—was not included in the advice of Dr. Hopkinson, the expert, was that they were not known to him. That seemed scarcely an adequate and sufficient reason, particularly as their tender was £2,833 below those accepted. Davy Brothers were working in conjunction with the Electrical Construction Company, of Wolverhampton; and had Dr. Hopkinson taken the trouble to make inquiries, he would have found that the Sheffield firm was an eminently competent one, and entitled to every consideration, as a firm paying something like £900 in rates. Mr. Firth endorsed the remarks of Mr. Fisher so far as regarded giving consideration to Sheffield firms, and he thought it important if anything went wrong that they should have the firm at hand to repair it. Mr. Marsh protested against the language of Mr. Fisher and Mr. Chapman. As Sheffield manufacturers and citizens, they ought not to

sneer at things made in the States and in Germany, because those who made them were the best customers for the special steel used in the manufacture of this electric work. Mr. Hobson said they had a strong desire that what work could be done should be done in Sheffield, and they had gone so far as to inquire what Sheffield firms could do the work they required. Alderman Clegg, in reply, said he had always shown, and should always show, the greatest consideration for local firms. But if conditions were not equal, and they could not satisfactorily compete with outside firms, then it was against the principles of economy to confine themselves to local firms. The Council would remember that when the very first tender was given out by the Committee, he publicly expressed his regret that there was no Sheffield firm with enterprise enough to tender for those contracts, and as far as regarded Mr. Fisher's speech, he could only say that that gentleman had not advanced Messrs. Davy Brothers's interests by it. The section about to be laid down was the most important one, and it was absolutely essential that they should have the best work on it. Messrs. Davy Brothers had had no previous experience in the electrical equipment of tramways. The Council agreed to the recommendation going back.

South Staffordshire.—The Earl of Jersey and Colonel Boughey, commissioners under the Light Railways Act, sat at Dudley on Saturday last to hear evidence on the application of the British Electric Traction Company for an order to construct light railways in the district of Dudley and the neighbouring townships. Messrs. Sydney Morse (solicitor), E. Garcke (managing director), and S. Sellon (engineer), appeared on behalf of the British Electric Traction Company, and the various authorities were represented. Mr. Sydney Morse explained that in connection with the existing Dudley and Stourbridge Tramway, which was the basis of the scheme for which a provisional order was required, it was proposed to make extensions from Dudley to Kingswinford, through Pensnett, from Kingswinford to Stourbridge; from Stourbridge to Kinver, and from Dudley to Cradley, through Netherton, Old Hill, and Cradley Heath, The total length of the lines would be 8 miles 5 furlongs 4·60 chains. The scheme really formed part of the larger scheme of the Birmingham and Wolverhampton District Tramways, a Bill on behalf of which was introduced by the same promoters in the last autumn session, but was eventually dropped. The directors of the British Electric Traction Company were, at the present time, negotiating for the purchase of the South Staffordshire Tramways, and so far as those tramways were electrical his clients were working them under arrangements. They wanted to purchase the South Staffordshire Tramways before December 31st next, at an agreed figure. With regard to the Dudley and Stourbridge Tramways Company, the terms of purchase had been practically concluded and agreed upon. The South Staffordshire Tramway Company had running powers into a portion of Dudley. They had the support of the Kingswinford Parish Council in reference to the line on the west, and the new line on the east was promoted on the suggestion of the Dudley Corporation. So far as he was aware no local authority except Dudley appeared to offer opposition to the preamble of the Bill. Mr. Emile Garcke (managing director of the company) stated that in the event of the company carrying out their present scheme, it would be possible to ride in a tramcar from Stourbridge through Dudley to Walsall.—Mr. Morse observed that the point on which the Dudley Corporation did not agree with the company was with respect to the supply of the electrical current in the Dudley district. The point was one on which expert evidence was necessary, and time had been taken to consider the matter.—Mr. Garcke read a communication from Mr. Warmington, in which the Town Council stated that they could not negotiate further unless the company were prepared to accept their terms—namely, 2½d. per unit of electric power up to 300,000, and 2d. per unit above that quantity up to 500,000. The company replied that that price was excessive. The price asked for by the Dudley Corporation for supplying electrical power to the company was excessive, and one which they could not pay with any chance of making the lines remunerative. The company had made arrangements with several corporations for the supply of electrical power at very much lower prices than those quoted by the Dudley Corporation, and one important company, who proposed to obtain powers for generating electricity in the immediate district, were prepared to give them a supply at 1½d. per unit. If the Dudley Corporation exercised their powers under the 43rd section of the Tramways Act, the company would still carry out the remainder of the scheme. The company's lines would then only come up to the boundary of Dudley. He quite agreed that the plant could be worked more profitably if the Corporation supplied electricity by day as well as by night. He understood that if his company paid the Dudley Town Council the price they asked for the supply of electricity, that authority would agree to all the other points in the draft agreement. Mr. S. Sellon (engineer to the company) said that the cost of the 8½ miles of lines in the present scheme would be £51,682. He had hoped to be able to take the existing tramways through High Street, Stourbridge, in order to connect it with the Hagley and Lye districts, which could not be done unless they could get a connecting link through Stourbridge. If he could not get further than the boundary of Dudley, he should drop his scheme so far as Netherton was concerned. If the Corporation bought the lines in their district, and the company worked the remainder of the tramway, the public would be very badly served. The company desired to work the whole of the line from one central generating station. It was quite reasonable for Dudley Corporation to wish to supply the electrical power in their own area, but the price they asked was unreasonable.—Mr. Hooper said that, in offering to supply the company with an electric supply at the price they did, the Corporation were fortified by the opinion of four of the leading experts of the district and the experience of various corporations throughout the country. He did not think that the question of price would have been raised at that inquiry, or they would have produced expert evidence. Lord Jersey said that the Commission could not go into the question of the price of electrical supply, which ought to be fixed by arbitration if they could not agree upon it. The only opposition was from the Dudley Council, and after a very lengthy inquiry a portion of the tramway was allowed, but the decision, to be in order, was reserved, with a recommendation for a mutual arrangement between the Town Council and the promoters.

Taunton.—The Taunton electric tramway scheme is understood to have fallen through. It was stated that the Light Railway Commissioners had no power to make an order for the construction through the county; but when this point was raised at the recent inquiry, Lord Jersey made some rather significant observations thereon. A protest on the part of ratepayers was supported by members of the Market Trust, five voting against. This is stated locally to be the cause of the scheme falling through.

TELEGRAPH AND TELEPHONE NOTES.

Dundee Telephones.—About eight months ago the National Telephone Company, Limited, came to an agreement with Dundee Town Council with the object of reconstructing the whole telephone system on the metallic circuit principle. Operations have been proceeding for some time in laying the cables, and the work is pretty well advanced.

German Telegraphs in Africa.—A daily paper says that the Anglo-German negotiations with reference to the connecting of the German South-West African telegraph line with the Cape Colony system are so far advanced, that a Bill on the subject will probably be laid before the Reichstag this winter.

Italian Telephones.—A telephone line between Treviso and Venice has been inaugurated by Signor Sineo, Minister for the Postal and Telegraphic Department. In his speech on the occasion, Signor Sineo said that he was anxious to promote the opening of State telephones, and hoped the condition of the country's finances would soon allow this object to be realised.

London Telephones.—The Bridges Committee reported to the London County Council on Tuesday that they had considered an application from the National Telephone Company for permission to lay two 3-inch pipes under the carriageway of Waterloo Bridge, and two 3-inch pipes beneath the down stream footway of Westminster Bridge for the purpose of conveying telephone wires across the bridge. The Council had already sanctioned the Charing Cross and Strand Electricity Supply Corporation laying wires across Waterloo Bridge, and the National Telephone Company proposed to lay their pipes in the trench to be formed by the Corporation, which would be of a sufficient width to receive the two additional mains of the Telephone Company. With regard to Westminster Bridge the National Telephone Company proposed to lay two 3-inch mains beneath the asphalte of the down stream footway of the bridge. As the Committee were informed that there was no objection to the application being granted in both cases, they recommended that approval should be given conditionally on the company paying £20 annually to the Council in each case.

Loud-Speaking Telephony. — Admiral Sir Michael Culme Seymour, Commander-in-Chief at Portsmouth, was present last week, says the *Daily Mail*, at the trial of the Graham patent loud-talking naval telephone, on board the new battle-ship *Cæsar*, now completing for sea. The telephones have been fitted from the conning tower exchange to all the casemates on the starboard side, while from the casemates on the port side ordinary voice tubes, as used on warships, have been fitted, the idea being to thoroughly test the two systems when at sea. It is claimed for the new invention that it is not affected by the noise of machinery or by gunfire. The trials were severe, as workmen in all parts of the ship were creating considerable noise, but the conversation could be easily heard, and at some distance from the transmitter, whereas through the voice tubes the hearing was very difficult.

The Field Collection.—According to the *Electrical World* (New York) the National Museum at Washington has just been enriched by a very valuable (and to electricians more especially) interesting collection. This latter comprises the private papers of Mr. Cyrus W. Field, relating to the laying of the first Atlantic cable, cable despatches first sent, objects with which Mr. Field worked out the idea of laying the cable, and many other things of interest pertaining to the project. The correspondence and autograph copies of telegrams sent by Mr. Field to the President of the United States, and other eminent persons, are included. The globe, which was constructed in London, and on which Mr. Field traced the course of the cable to be laid from Newfoundland to Ireland, forms an attractive object of the collection. It is about 18 inches in diameter, on a stand, with a magnetic compass underneath, and shows many signs of hard usage. The journal kept by Mr. Field, and notes of deep-sea soundings set down by him and officers of the *Great*

Eastern, which laid the cable, are part of the collection. Mr. Field's private library, with all the literature relating to the work of laying the cable, forms another part. There are also copies of medals presented to Mr. Field by Congress and the French Government, engrossed resolutions passed by public bodies in the United States and in Europe, a cane from the wood of the *Great Eastern*, &c., as well as cases containing sections of the first Atlantic cable. The collection was secured by Prof. Watkins from Mrs. Isabella Field Judson, of Dobbs Ferry (New York State), who is a daughter of the late Mr. Field.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro (Brazil)	Sept. 29th, 1897 ...	Nov. 17th, 1897.
Paramaribo-Cayenne ...	Oct. 25th, 1897 ...	...
Santiago-de Cuba-Guantanamo	Oct. 29th, 1897 ...	Nov. 9th, 1897.
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Santarem ...	Oct. 23rd, 1897 ...	...
Otranto-Vallona	Oct. 11th, 1897 ...	...
Cadiz-Teneriffe	Oct. 26th, 1897 ...	...
Bundaberg-New Caledonia ...	Nov. 4th, 1897 ...	Nov. 9th, 1897.
San-Thomé-Loanda	Nov. 8th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena-Barranquilla (Columbia)	July 4th, 1896 ...	...

Western Union Telegraph Company.—The business of this company, which formerly expanded year by year, has, since the troubles of 1893, been barely maintained. In 1867 the number of telegrams despatched by the company was 5,879,282. In 1877 the number had risen to 21,158,941, and in 1887 it stood at 47,394,530. In 1892 the total was carried to 62,387,298, and in 1893 there was a further advance to 66,591,858. In 1894, says *Engineering*, there was a drop to 58,632,237 telegrams, and since then the business of the company has been practically stationary, the number of messages despatched in 1895 having been 58,307,315; in 1896 58,760,444, and in 1897 58,151,684. It may be observed that each of the years mentioned in this recapitulation closed June 30th. The revenue of the company also advanced satisfactorily up to 1893, but since then it has fallen off. In 1867 the receipts were $6,568,925; in 1877 $9,812,353; in 1887, 17,191,910, and in 1892 $23,706,405. In 1893 the revenue attained its maximum, viz., $24,978,443, but in 1894 it receded to $21,852,605. In 1895 it stood at $22,218,019, in 1896 at $22,612,736, and in 1897 at $22,638,859. Although the business of the company has been stationary during the last three years, the length of wire stretched, and the number of offices in operation, have been gradually increased. In 1867 the company owned 85,291 miles of wire; in 1877 194,323 miles; in 1887 524,641 miles, and in 1892 739,105 miles. In 1893 the total was carried to 769,201 miles; in 1894 to 790,792 miles; in 1895 to 802,651 miles; in 1896 to 826,925 miles, and in 1897 to 841,002 miles. The number of offices in operation in 1866 was 2,565; in 1877 7,500; in 1887 15,658, and in 1892 20,700. In 1893 the total was carried to 21,078; in 1894 to 21,166; in 1895 to 21,360; in 1896 to 21,725, and in 1897 to 21,769. The check which the business and revenue of the company have experienced since 1893 has accordingly not been due to a want of energy on the part of the management; it is simply the result of the depression which has prevailed in nearly all branches of American business. The net revenue of the company in 1896-7 was $5,732,203, as compared with $5,897,980 in 1895-6, and $6,141,390 in 1894-5. The amount distributed in dividends in 1896-7 was $4,792,855, as compared with $4,767,805 in 1895-6, and $4,767,734 in 1894-5. Interest on bonds absorbed $895,510 in 1896-7, as compared with $893,967 in 1895-6, and $893,822 in 1894-5. The amount expended in telegraphs, investments in other telegraph companies, franchises, patents, &c., stood at the close of June, 1897, at $101,761,510, as compared with $101,306,874 at the close of June, 1896. The business of the company has somewhat revived since June this year, and there is little doubt that the undertaking will at once profit from any general restoration of business activity in the United States.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bishop Auckland (Durham).—November 24th. The Board of Guardians want tenders for the provision of telephonic communication between the several blocks of buildings at the Workhouse. Particulars from Mr. Wyld, Master of the Workhouse.

Blackburn.—November 27th. The Corporation wants tenders for eight tramcar bodies with trucks, motors, controllers, trolley posts, &c. Engineer, Mr. E. M. Lacey, 10, Delahay Street, S.W. See our "Official Notices" last week for particulars.

Blackpool.—November 22nd. The Corporation wants tenders for various works required in the conversion of the present system of electric traction. There are four sections as follows:—

A. Steel columns, brackets and straining posts.
B. Trolleys, trolley wire and insulators.
C. Controllers, motors and gearing.
D. Mains and section fuses.

Borough electrical and tramway engineer, Mr. Robert C. Quin. See our "Official Notices" October 29th for further particulars.

Canterbury.—The Corporation Electric Lighting Committee is inviting tenders for the supply of Lancashire boilers, and boiler house plant, steam dynamos, condensers, &c., for the engine house, overhead travelling crane, switchboard, accumulators, mains, arc and incandescent lamps, meters, &c. Consulting engineer, Mr. Robert Hammond. See our "Official Notices."

Dundee.—December 3rd. The Gas Commissioners want tenders for an economiser for the electricity works. Electrical engineer, Mr. W. H. Tittensor. See our "Official Notices."

France.—November 30th. Tenders are being invited by the French Post and Telegraph Authorities for the supply of a quantity of telegraphic apparatus of the Baudot type. Tenders to be addressed to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Hull.—November 25th. The Corporation is inviting tenders for the supply of about 2,800 tons of steel girder tramway rails, fish-plates, sole-plates, tie-rods and bolts. For particulars write to Mr. A. E. White, city engineer, Town Hall.

Italy.—December 30th. Tenders are being invited by the Municipal Authorities of Catanzara, for the construction of a tramway between the centre of the town and the railway station, to be operated either by electricity, steam or cable.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

Londonderry.—December 9th. The Corporation want tenders for the supply of carbons for one year. Electrical engineer, Mr. J. Christie. See our "Official Notices" this week.

London.—December 2nd. The Metropolitan Asylums Board want tenders for alterations and additions to the electric fire alarm system at the South Eastern Fever Hospital. See our "Official Notices."

Singapore.—December 31st. The Municipal Commissioners are inviting tenders for the lighting of street lamps for a period of five years. Particulars from Mr. C. C. Lindsay, 167, St. Vincent Street, Glasgow, or the secretary to the Municipal Council.

Spain.—November 21st. Tenders are being invited by the General Direction of the Spanish Posts and Telegraphs in Madrid for the supply of 25,000 porcelain insulators. Tenders to be sent to the Direccion General de Correos y Telegrafos, Madrid.

Warrington.—December 3rd. The Cheshire Lines Committee are inviting tenders for the supply of stores and materials for the year 1898. There are nineteen items, No. 6 being for telegraph materials, instruments, wire, &c. Particulars from Mr. S. Saxton Barton, storekeeper, Cheshire Lines, Warrington.

York.—November 22nd. The North Eastern Railway Company invites until noon to-day for the supply of the following articles to be delivered as required at the Company's telegraph stores at York, during the six months ending June 30th next, viz.: 1. Telegraph apparatus; 2. Telegraph wires and line stores. Particulars from Mr. Graves, Telegraph Department, York.

CLOSED.

London.—The following is a list of the tenders sent in for the electric wiring of the Guildhall School of Music Extension. The lowest tender was accepted. The difference between the amount of the highest and lowest is, to say the least, remarkable:—

	£	s.	d.
Messrs. Vaughan & Brown	750	0	0
Messrs. Drake & Gorham	738	18	0
Messrs. Wenham & Waters..	579	0	0
Messrs. R. Dawson	507	12	0
Messrs. Lund Bros.	495	0	0
Messrs. R. Phipps & Co.	464	0	0
Messrs. C. A. Hemingway	405	7	6
Messrs. Gulich & McIntyre..	392	4	6
Messrs. Johnson & Phillips..	357	0	0
Messrs. Bergthiel & Young .. .. .. (accepted)	342	15	0

Torquay.—At the last Council meeting it was agreed to accept the offer of the Reason Manufacturing Company, of Brighton, to supply 37 maximum demand indicators at a cost of £68 10s. 6d. net, and of Messrs. Venner & Sillar, of London, to supply a similar number of meters at a cost of £160 19s. 6d. Mr. W. H. Trentham, consulting electrical engineer, forwarded a report on the progress of the works. He referred to the habitual and continued promises of completion on the part of the engine makers.

FORTHCOMING EVENTS.

1897.

Saturday, November 20th, at 3 p.m.—Institution of Junior Engineers' visit to the Islington Vestry Electricity Works, Eden Grove, Holloway Road.

Saturday, November 20th, at Sunderland.—(Council Chamber, Town Hall), Northern District meeting of the Incorporated Association of Municipal and County Engineers. Among the papers to be read is one by Mr. J. F. C. Snell, A.M.I.C.E., on "The Sunderland Electric Generating Station." The Electricity Works will be visited in the afternoon. Dinner at the Grand Hotel at night.

Monday, November 22nd.—Last day for the receipt of electric tramway plant tenders for the Blackpool Council.

Monday, November 22nd, at 8.30 p.m.—Imperial Institute. Mr. E. S. Bruce will read a paper on "Electric Balloon Signalling applied to Scientific Exploration in Arctic and Antartic Expeditons," fully illustrated by working models and experiments. Major P. A. MacMahon, R.A., F.R.S., will preside.

Tuesday, November 23rd.—Royal Victoria Hall, Waterloo Bridge Road, S.E. "The Gas Helium and How It was Discovered," by Prof. Ramsay, F.R.S.

Wednesday, November 24th.—Institution of Electrical Engineers; Dinner, Hôtel Cecil, 7.30.

Wednesday, November 24th.—Society of Arts, John Street, Adelphi, W.C., "Progress of metallurgy and metal mining in America during the last half century," by Prof. James Douglas.

Thursday, November 25th.—Last day for the receipt of tenders for Hull tramway rails, &c.

Thursday, November 25th, at 8 o'clock.—City and Guilds Technical College, Finsbury, E.C. The third of a series of six lectures on "Electric Traction," by Philip Dawson, M.I.C.E.

Thursday, November 25th at 8 p.m.—Institution of Electrical Engineers. Adjourned discussion on Mr. L. Epstein's paper on "Accumulator traction on rails and ordinary roads."

Friday, November 26th.—Electro-Harmonic Concert; Ladies' night.

Friday, November 26th.—Physical Society meeting.

Saturday, November 27th.—Sanitary Institute. Visit to the Shoreditch Vestry refuse destructor and electric light works under the guidance of Mr. C. N. Russell, the chief electrical engineer.

Monday, November 29th.—Yorkshire College Engineering Society, Leeds. Paper by Mr. Herbert Perkin on "The Engineering Features of the Sinking and Equipment of a Modern Colliery" (*illustrated*).

Monday, November 29th, at 8 o'clock.—Society of Arts. Cantor lecture. First of a series of three lectures on "Gutta Percha," by Dr. Eugene F. A. Obach, F.I.C., F.C.S., M.I.E.E. Synopsis of first lecture: *The Raw Material.*—The year 1847—Early history and the Society of Arts—General properties and distinction from Caoutchouc—Botanical derivation and geographical distribution—Expeditions in search of gutta trees and experimental cultivation—Analysis of particular specimens and of various commercial brands—Exports from Singapore, imports into the United Kingdom and fluctuation of prices.

Monday, November 29th, at 3 o'clock.—Cannon Street Hotel. Extraordinary general meeting of Crompton & Co., Limited, to pass resolutions *re* reduction of capital. Preference shareholders' meeting at 3.30 p.m.

Tuesday, November 30th.—Royal Society. Anniversary meeting, 4; Annual dinner, Hôtel Métropole, 7.

NOTES.

American Electro-Therapeutic Association.—From the secretary, Dr. John Gerin, of 68, North Street, Auburn, N.Y., we have received a list of the officers, council, and committees elected at the seventh annual meeting of this Association. The president for 1897-8 is Dr. Charles R. Dickson, of Toronto. There are special committees for the following branches of electro-therapeutics:—Induction coils and alternators; constant current generators and controllers; meters; electrodes; static machine and condensers; electric light apparatus for diagnosis and therapy and the Röntgen ray; cataphoresis. The eighth annual meeting will be held in Buffalo on September 13th, 14th and 15th, 1898.

Sax, Slatter & Co.—We have received another letter from Mr. Alfred Slatter, the managing director of the above firm, in which he replies to Messrs. Julius Sax & Co., whose communication appeared in a previous issue. Mr. Slatter states that Messrs. Julius Sax & Co. sold to his company for a large sum in hard cash, their Forester's Hall business as a going concern. The business has never been discontinued, and Messrs. Sax, Slatter & Co. were authorised by Messrs. Julius Sax & Co. to collect their accounts. Messrs. Julius Sax & Co. are not allowed under the agreement to start an opposition business. Mr. Slatter objects very strongly to Messrs. Sax's disparagement of the goods sold by Sax, Slatter & Co., and adds that they are exactly the same class of goods as were formerly sold by J. Sax & Co. The statement that Messrs. Sax, Slatter & Co. are not successors to the Forester's Hall business is altogether contrary to the terms of the purchase deed. These are Mr. Slatter's asseverations. We have ourselves closely examined the agreement referred to, and have come to the conclusion that Mr. Slatter purchased the goodwill, stock-in-trade, plant, &c., of the Forester's Hall business for a stated sum from Messrs. Julius Sax & Co., the name of Sax to be used in connection with the business only in conjunction with another name. The purchaser took over the book debts, liabilities, contracts, &c. Mr. Slatter is accordingly carrying on the business under the name of Messrs. Sax, Slatter & Co. These being the facts of the case, and it being a matter of interest mainly to the two parties mentioned, we think the correspondence should now come to a close.

Electric Motors in Tea Manufacture.—On the Thurbo Tea Estate of the Darjeeling Tea Company, electric motors are being employed for the operation of machinery used in the manufacture of tea. Mr. Davidson Rickie, the company's electrical engineer, is responsible for the experiment, which is understood to be a success. The electrical plant, which has been in operation since the beginning of last year, is driven by means of water-power. The Rungbong River supplies water, which is conveyed down a 56-feet fall in 16-inch steel pipes, to a 40-H.P. Jonval turbine, which drives, by means of belt and pulley, a 30-B.H.P. Manchester dynamo giving 70 amperes at 320 volts pressure. Overhead wires carry the current across the estate to the tea factory, where a 24-B.H.P. Manchester motor drives the following machinery:—Two large tea driers, two tea-leaf rollers, one tea packer, two tea sifters, and one tea cutter. The speed of the motor is regulated by a graduated 10-stop switch, and it is also supplied with drop-sight oil cups and carbon brushes. From the same plant lighting current is furnished for the whole of the factory. The *Indian and Eastern Engineer* for September contains an illustrated description of this enterprise, and enumerates the advantages of electricity for such work in a place like Darjeeling, where the difficulties and cost of transport of firewood or other fuel are excessive. To get fuel to the tea gardens is a very serious matter, and the utilisation of water-power for the operation of electrical machinery removes the necessity for fuel, and the difficulty is overcome.

Electric Lighting Shares.—The financial Press has been saying a good deal in praise of electric lighting stocks and shares of late. The last issue of *Money* has the following:—

> Electric lighting companies have come to the front very rapidly during the past year. During the early part of last year City of London Electric shares were obtainable at 13½. To-day they are not to be had at 27. Of the St. James's and Pall Mall Company prominent mention was made here over two years ago, when the shares stood at a comparatively modest quotation. City of London Electric shares are but little likely to remain below 30 for long, as office after office becomes a regular customer. The company has almost as good a monopoly as the Gas Light and Coke, and as it supplies the rich, or that section of the community who are supposed to be rich, there is no grumbling at rates.

Wireless Telegraphy.—The experiments in ethereal telegraphy which have recently been carried out at Dover under the direction of the Postal Telegraph Department, have terminated for the present. We imagine, however, that much remains to be done, many defects to be overcome, before the Marconi system can be pronounced a practical success.

The Rand Electric Power Plant.—The power station of the Rand Central Electric Works, Limited, which was recently visited by President Kruger and members of the Volksraad, is briefly described in several of the South African papers. The *South African Mining Journal* gives the following description:—

The delivery of coal from the Brakpan Colliery is automatic—the empties being returned by the Electric Company's own locomotive; there is a coal shed capable of storing three weeks' supply. The stoking is mechanical, by means of the Leech feeder, which is such a favourite in Germany. There are 10 boilers of the Steinmueller multitubular type, each of 600 I.H.P., with 3,300 square feet heating surface, and 14 atmospheres pressure, and estimated to supply 2·20 lbs. steam pressure per square foot per hour. The great importance attaching to the cleanliness of the boilers necessitates surface condensation, as well as the careful purification of the feed water; each boiler requires some 45,000 gallons per hour of condensing water. The large pan, on the margin of which the equipment is erected, would have allowed a ruinous amount of evaporation, therefore a catch-water has been constructed out of part of its area, with a superficies of about 1,000,000 square feet for the purpose of cooling this considerable amount of condensing water, which will run up to 250,000 gallons an hour. The supply is drawn from the colliery mine water, as well as from the larger portion of the pan. The four engines (there is room left for a fifth and for all its accessories) are of the triple-expansion vertical type (manufactured by the Saechische Maschinen Fabriek), of 1,000 brake H.P. normal (or 1,500 I.H.P. maximal) load; each engine is able to deliver a minimum at the farthest point of delivery of 700 H.P., as measured on the motor shafts at the mines. The efficiency of the power transmission is calculated at a loss of from 25 per cent. to about 35 per cent., according to the distance, the longest stretch being to Paardekraal (Krugersdorp), some 28 miles from the central station. At present the current is being transmitted as far as the Crown Deep (between Booysens and Fordsburg), and—three engines only being in constant use, and the fourth being in reserve—is equal to 2,100 H.P., the loss of transmission for that distance is 30 per cent. The dynamos, each weighing 80 tons, are coupled direct on to the driving shafts, are 14 feet in diameter, and are run at 100 revolutions per minute. The electric current produced is an alternating three-phase current of low tension. The transformers at the central station bring it up to 10,000 volts tension. Six cables form the means of transmission along the line of reef; the iron carrying poles are strong, and are placed short distances apart; the cables are fitted with a wire net-like arrangement underlying them, for the purpose of catching them and keeping them from the ground in case of breakage. These cables are of uninsulated copper rope, and are supported at each pole in such a manner that each cable has a spiral course in relation to the others, thus doing away with the powerful and troublesome currents ordinarily induced by untwisted transmitters in neighbouring telegraphic and telephonic installations. The cables are topped by a line of ordinary barbed copper wire for lightning conductor purposes. All dynamos and transmitters are safeguarded by a lightning arrester, invented by the firm, which will prevent even a $\frac{1}{100}$th of a second flash from entering the installation and damaging the armatures. On the mines the high tension current is re-transformed by means of secondary transmitters into a low tension current, available for either motive power or illuminating purposes. The contracts already entered into for these two purposes number 18.

Gas Engines for Electric Lighting.—The *Practical Engineer* abstracts from *La Lumière Electrique* a note on the advantages possessed by gas engines for driving electric lighting plants, whether on a large scale or for private plants. The four points stated are:—

1. The facility with which gas can be obtained from existing sources.

2. The gasworks themselves may be used as a central station.

3. It has been shown that 1 cubic metre of gas gives—(*a*) In an ordinary gas burner of 16 candle-power a maximum of 91 candle-hours. (*b*) In an incandescent electric lamp a minimum of 162 candle-hours. (*c*) In a Wenham lamp a maximum of 200 candle-hours. (*d*) In an arc lamp a minimum of 654 candle-hours.

4. If the electric lighting were carried out by the gas company, a smaller staff will be needed than in the case of an independent company, with which the advantages of combining both systems of supply, thus obviating competition, should be considered; and further, the gas supplied to the engines would, under these conditions, be obtained at the cost of production, and not at the selling price.

A New Journal.—A new illustrated weekly paper is to be published at Manchester with the title of the *Mechanical Engineer*, the price being 6d. Mr. William H. Fowler, Wh.Sc., M.I.M.E., A.M.I.C.E., &c., is the editor, and the Scientific Publishing Company, of Hodson's Court, Corporation Street, Manchester, are the proprietors.

Electric Tramways and Telephones—The Prevention of Induction.—A method of diminishing the disturbances due to induction from electric traction, &c., in single line telephones, which has been successfully tried at Brussels, is briefly described in the *Practical Engineer*. The same method has been also employed on the Liége circuit of Herstal, a circuit offering special difficulties, owing to the close proximity of an electric tramway to the telephone line. It is a departure from recent attempts to minimise the disturbances by inserting high resistances in the line circuit, such resistances being either inductive or non-inductive. Whilst having some effect, this method has the disadvantage of reducing the intensity of sound in the receivers; in some cases, where trouble has arisen from leakage currents working the annunciators at the exchange, the plan adopted with more or less success has been to insulate the subscribers' earth connections wherever it has been thought likely that these were making contact with the return rails, and at the same time insulating these rails from earth, which in many cases is difficult, owing to the rails having to be connected to neighbouring conductors, in order to prevent destruction by electrolysis. The *Journal Télégraphique* describes the new method in use at Brussels. It consists in employing a common return wire of low resistance for all subscribers, which, in order to completely eradicate the effects of possible disturbances, should have the same capacity and self-induction as the line wire, the diameter and length being the same, the return wire being brought as near the exchange as possible. Owing to the high sensitiveness of the electro-magnetic call bells now in general use, it has been found necessary with this system to fit an automatic device arranged to change the earth return for the wire return, when unhooking the receiver, in order to prevent other subscribers' bells from ringing; and further, for the complete solution of the problem, there is another contingency to be met, that is, the possibility of two subscribers removing their receivers simultaneously, when the return wire will become common to both. This has been done by supplying a two-way switch, which offers the alternative of using the earth return, in which case, however, the disturbances will reappear.

The City Company and the Commissioners of Sewers.—The Streets' Committee of the Commission reported on Tuesday that an action had been brought by the City of London Electric Lighting Company against the Commission, in regard to the payment of their account for public electric lighting and the expenses of electric inspection up to Christmas last. The company claimed £16,669, but the Commission alleged their right, under the Act, to deduct £11,427 in respect of their expenses incurred by them during the period for electrical inspection and other matters. The company refused to accept the balance tendered them and brought the present action. The Master made an order on the Commission to pay the company the amount claimed, less the sum alleged to be due to them, but Mr. Justice Day reversed that order, and directed the Commission to pay the full amount into Court. The Commission were now about to appeal to the Divisional Court. It was also reported that, under the Telegraph Acts, the Postmaster-General had issued a summons against the Commission in the City of London Court in respect of their refusal to sanction the opening of the public way for the laying of tubes for use by the National Telephone Company, who had declined to make any concessions to the public in respect of that privilege.

Society of Patent Agents.—On Wednesday last, at the annual meeting of this Society, the Presidential Address was delivered by Mr. J. Sinclair Fairfax. Subject: "The Classification of Patents in Relation to a Preliminary Search for Novelty, and Patent Law Reform."

Bust of Michael Faraday.—On Monday afternoon last a bust of Michael Faraday was unveiled at the Michael Faraday Board School at Walworth. The bust was presented by the managers of the Royal Institution, and is a copy of the original bust executed by Matthew Noble. Sir J. Crichton Browne, F.R.S., and other representatives of the Royal Institution, were in attendance.

Direct Spanish Telegraph Company, Limited.—On Saturday last, the members of the staff of the general offices of the Direct Spanish Telegraph Company held a dinner at the "Trocadero" Restaurant, London, to commemorate the twenty-fifth anniversary of the incorporation of the company, Mr. F. T. Preddle presiding. Amongst the guests invited to meet the staff were Mr. Charles Gerhardi, manager of the company, Mr. W. Hibberdine, Senor Don N. E. Jauralde, Mr. H. St. L. Smith, Mr. W. J. Hale, Mr. Guildford Dudley, Mr. J. F. Mills, &c. After the usual loyal toasts had been cordially received, the chairman proposed, "The Success and Continued Prosperity of the Direct Spanish Company," remarking that they were there not only to commemorate the twenty-fifth year of the company's existence, but they were celebrating a quarter of a century that the genial manager had successfully directed its destinies, for without him the company would never have reached its present high and satisfactory position. Mr. Gerhardi had thrown his whole heart and his entire energy into the interests of the company, and never during the whole 25 years had he for an instant forgotten the welfare of the staff at home and abroad. Mr. Gerhardi, in reply, thanked those present for the kindly feelings expressed, and said that the many flattering remarks which had been made on this and other occasions connected with the twenty-fifth anniversary of the Direct Spanish Company's existence, was evidence that a man in a position of authority was respected and appreciated when he received and dealt with his staff in a frank and cordial manner. He would say for himself that the welfare and comfort of his staff had always been to him a matter of consideration, and never more so than when the company was in a prosperous condition, as he was pleased to say was now the case. Other toasts followed, including "Spain and Her Representatives in this Country," which was responded to by Senor Don N. E. Jauralde; "The Staff," responded to by Mr. C. E. Morgan; "The Officials of the Eastern Telegraph Company," responded to by Mr. W. Hibberdine. It was resolved to despatch the following telegram to the representative of the company at Madrid:—"The officials of the administrative offices of the Direct Telegraph Company assembled at a dinner to-day (Saturday) to celebrate the 25th anniversary of the foundation of the company, have unanimously and enthusiastically drunk, on the proposal of Mr. Hibberdine, the prosperity of Spain, and coupled with this toast the name of Il Senor Nicasio Jauralde, so well known and so much beloved in this country, to which toast this gentleman feelingly replied." To which the following reply was received:—"The staff of the Spanish Administration feel most satisfied to hear of the toast proposed by Mr. Hibberdine on Saturday last, and join our distinguished countryman and friend, Don Nicasio Jauralde, in expressing to you and to the gentlemen assembled at the dinner their most earnest thanks." Some songs and recitations having been given by the staff and their friends, a most enjoyable and pleasant evening's proceedings terminated.

Large Power Distribution Scheme.—According to a Sheffield paper, the General Power Distribution Company has been formed for the purpose of carrying out a scheme for the supply of electrical power in Notts, Derbyshire, Lincolnshire, and the West Riding of Yorkshire. A Bill has been deposited. It is proposed to erect a great generating station at Market Warsop, near Mansfield, and adjoining the collieries of the Staveley Coal and Iron Company, Limited, and to supply electric energy to all the towns and villages within a radius of 25 miles at a very low price. The area embraces Sheffield, Nottingham, Lincoln, Gainsboro', Derby, Retford, Worksop, Mansfield, Ilkeston, Newark, Rotherham, Chesterfield, and many villages which contain manufactories of various descriptions. The promoters are understood to include several large coal owners in the districts mentioned, and several well-known capitalists, who are associated with the British Thomson-Houston Company.

Paper.—Last Friday evening, at the St. Bride's Foundation Institute, before the London Association of Parochial Engineers, a paper on "Electricity Supply from Central Stations" was read by Mr. J. T. Baron, M.I.E.E. A discussion followed.

Royal Institution.—Prof. Oliver Lodge, F.R.S., will deliver the first of a course of six Christmas Lectures (specially adapted to young people) on "The principles of the Electric Telegraph," at the Royal Institution on December 28th. The remaining lectures will be given on December 30th, 1897, and January 1st, 4th, 6th, 8th, 1898.

Personal.—On Friday last the yearly ceremony of appointing Sheriffs took place in the Lord Chief Justice's Court. Mr. John Verity, of 31, King Street, Covent Garden, stands third on the list for the County of London.

Mr. Frederick T. Garrett, a partner in Messrs. F. T. and A. Garrett & Co., electrical engineers, of Northampton, is the new Mayor of Dunstable.

Lecture.—On 15th inst. Prof. Barrett lectured at the Kingstown Men's Christian Institute, on "Electric Trams," the lecture being illustrated by lantern slides and the aid of models.

Motors and Mail Carts.—The Post Office has been experimenting for some weeks past with oil motor mail vans.

The Royal Society.—Among the other papers down for reading before this society yesterday afternoon was one by C. Chree, F.R.S., on "Account of a Comparison of Magnetic Instruments at Kew Observatory."

The Institution of Civil Engineers.—At the forthcoming meeting the following paper will be read and discussed:—"Central Station Electric Coal Mining Plant in Pennsylvania," by Mr. W. S. Gresley, Assoc. M. Inst. C.E.

The Glasgow Appointment.—For the post of electrical engineer to the Corporation there were 33 applications, including a number of London men. A small committee is making a selection from these.

Electric Curve Tracer.—Owing to an accident we are compelled to hold over till next week the curves made by Prof. Rosa's apparatus.

NEW COMPANIES REGISTERED.

Premier Electric Lamp Syndicate, Limited (54,745).—Registered November 8th with capital £30,000, in £5 shares, to adopt a certain agreement, and to carry on the business of manufacturers of, and dealers in, lamps, wires, lines, and electrical apparatus, electricians, engineers, suppliers of electricity. The subscribers (with one share each) are:—J. B. Atherton, Rough Grange, Gateacre, Lancashire, manufacturer; C. Petrie, J.P., New Heys, West Derby, Liverpool; L. Higginbottom, Crown Iron Works, West Gorton, Manchester, engineer; J. Atherton, Singleton, Huyton, Lancashire, manufacturer; D. L. Chalmers, 5, Fenwick Street, Liverpool, chartered accountant; F. J. Leslie, 15, Union Court, Liverpool, solicitor; A. E. Haptie, 5, Durham Road, Seaforth, Lancashire, clerk. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first; qualification, £200; remuneration as fixed by the company. Registered by T. T. Hull, 22, Chancery Lane, W.C.

Power and Traction, Limited (54,749).—Registered November 8th with capital £10,000 in £1 shares, to carry on the business of an electric traction, power, and lighting company, to adopt a certain agreement, and to carry on the business of electricians, mechanical engineers, dynamo, lamp, and wire manufacturers and dealers, &c. The subscribers (with one share each) are:—R. A. Smith, Innisfallen, Strawberry Hill, Middlesex, engineer; G. A. Sprague, 2, Harbledown Road, Fulham, accountant; J. Meredith, 30, Parliament Street, S.W., clerk; C. J. Bosanquet, Ripley Lodge, Belvedere, Kent, engineer; J. W. Perkin, 1, Spring Grove Terrace, Leeds, engineer; W. S. Baron, Colton, near Leeds, cashier; C. G. Hampson, jun., 92, Elford Place, Leeds, engineer. The number of directors is not to be less than two nor more than seven. The first are: R. A. Smith and A. Hopkins; qualification, £300; remuneration as fixed by the company. Registered by Waterlow & Sons, Limited, London Wall, E.C.

Railway Lighting, Limited (54,759).—Registered November 9th with capital £75,000 in £1 shares (25,000 deferred), to carry out and perform the contract entered into by W. P. J. Fawcus with the Great Central Railway Company, entitling him to erect generating stations and plant, and to supply electric current to the said railway at the places therein mentioned, and to enter into an agreement with W. P. J. Fawcus. The subscribers (with one share each) are:—G. W. Lowcock, 40, Seymour Grove, Old Trafford, Man-

chester, electrical engineer; J. S. Raworth, 46, Christchurch Road, Streatham, S.W., civil engineer; F. A. C. Leigh, Blue Bell Farm, Knutsford, electrical engineer; S. C. Clirehugh, 14, Egerton Road, Fallowfield, engineer; A. E. Tanner, 563, Stretford Road, Manchester, engineer; W. P. J. Fawcus, Hale, Cheshire, engineer; E. E. Johnson, 17, Stann's Square, Manchester. The number of directors is not to be less than four nor more than seven; the first are W. P. J. Fawcus, J. C. Waterhouse, J. S. Raworth, and G. W. Lowcock; qualification, £100; remuneration, £500, divisible, when 6 per cent. is paid to ordinary shareholders. Registered office, 78, King Street, Manchester.

C. W. Woodcock & Co., Limited (54,804).—Registered November 12th with £5,000 capital in £1 shares, to acquire the business carried on by C. H. Elliot & E. J. Tumber at 17½, Albion Buildings, Aldersgate Street, E.C., and the business carried on by C. W. Woodcock at 1A, Sumner Street, S.E., to adopt a certain agreement, and to carry on the business of gas engine manufacturers and mechanical, general and electrical engineers. The subscribers (with one share each) are:—C. W. Woodcock, 7, Westwood Park, Forest Hill, S.E., engineer; C. H. Elliot, 50, Croydon Road, Beckenham, electrical engineer; E. H. Tumber, 8, Clitheroe Road, Clapham, electrical engineer; D. H. Tumber, 94, King Edward Road, South Hackney, brewer; F. Todd, M.R.C.S., 21, Finsbury Circus, E.C.; C. Woodcock, 7, Westwood Park, Forest Hill, S.E., warehouseman; S. Ponder, Foley Hatch, Purley, Surrey, gentleman. The number of directors is not to be less than two nor more than five; the first are: C. W. Woodcock, with £120 per annum; C. H. Elliot, with £60 per annum; and E. J. Tumber, with £60 per annum. Qualification £300. Registered office, 17, Albion Buildings, Aldersgate Street, E.C.

CITY NOTES.

The Wireless Telegraph and Signal Company, Limited.

The statutory meeting of this company was held yesterday at Cannon Street Hotel, Mr. E. Appleby presiding.

The Chairman said the meeting was merely called in accordance with the Act of Parliament, and there was very little to say. The whole of the capital had been subscribed, and they were engaged in developing what they considered to be valuable patents. Mr. Marconi had been carrying out experiments, which up to 12 miles had been quite successful, and in a fortnight's time he would have succeeded in transmitting messages nearly 20 miles. The experiments on Salisbury Plain had resulted in Mr. Marconi obtaining improvements in certain details which had been patented, and they were assured by Messrs. Carpmael that their patents were amply protected. The first application of the invention would be for signalling between lighthouses and the shore, and between lighthouses and passing ships. Experts had approved of the results of the experiments, and he was confident that when definite statements were laid before the shareholders they would be perfectly satisfied with the results.

After one or two questions had been put by shareholders, one of the members of the board said that the applications of the invention mentioned by the chairman was only the beginning; there were many other directions in which the system would prove its utility. They were going deliberately to work and were improving the details of the system, and he thought shareholders of the company were to be congratulated.

The Chairman said, in reply to a question, that the board had absolute confidence in the system.

Mr. Marconi mentioned the distances in this country and in Italy over which messages had been sent, and after a vote of thanks to the chairman, the meeting concluded.

Western and Brazilian Telegraph Company.

The ordinary general meeting of this company was held on Monday last at Winchester House, Mr. W. S. Andrews in the chair.

After referring to the loss through the death of their late colleague, Mr. Earle, and to the absence from severe illness of the managing director, Major Wood, the Chairman remarked that the statement of accounts presented that day was not satisfactory to any of them. He was, however, pleased to say that he believed that it was about the very worst they were ever likely to receive. The revenue from messages for the six months to June 30th last had amounted to £59,349, which was increased to £59,754 by interest and transfer fees. These figures compared with £71,082 for the June half of 1896, and consequently a falling off of £11,327 was shown. The expenses, too, were £44,575, exhibiting an increase of £7,147. The main increase was occasioned by the hire of the *Buccaneer* and the *Viking* during necessary repairs to their own steamer, the *Norseman*. Of the total increase of £7,147 in the expenses nearly £6,000 was for ships alone. The maintenance of cables, &c., had cost them £1,130. Altogether there had been increases exceeding £8,000 in the expenses, but economies in other items had reduced this increase to the amount he had mentioned. The main item making up the increase, £5,780, would now disappear from their accounts. As a result of the half-year's working they carried down profits, including £6,405 brought forward, of £21,584, from which they had to deduct debenture interest £8,983, and the income-tax £1,624, leaving £10,975 available. They proposed to supplement this sum by withdrawing £7,500 from the reserve fund, and this would enable them to recommend a dividend of 3s. per share, or at the rate of 2 per cent. per annum, the same as for the June half of 1896. In the period under review, up to June last, they had had to contend with the unfavourable exchange, which had pressed upon them with greater severity than ever. This and the closing by the Argentine Government of the line connecting the company's route with their territory, accounted for their much smaller receipts. This line was, however, now opened again, and it was recovering trade in a satisfactory manner. They understood that legal matters were pending in reference to this question, and it was therefore, perhaps, not advisable that they should go into it any further. The one salient feature of their meeting was that they recommended supplementing the dividend from the reserve fund, but he might state that among other objects the reserve fund was intended for the equalisation of dividends. What they proposed was, therefore, quite reasonable. It was true that they might have recommended the shareholders to minimise the dividend, but they thought that the shareholders had done quite enough for some years past, and it must be remembered that out of the revenues of the company they had reduced the debentures to an amount, as reorganised, of £359,521, with about £9,000 to come in, for which the money was already set aside. That made £399,521, and it was at 4 per cent.; and this sum took the place of £450,000 at 6 per cent. The courage with which the shareholders had acted, and the determination with which they had pursued the reduction of the debenture debt had entitled them to some claim upon the reserve fund, into which a considerable amount of this money had gone, for he might inform them that, after providing for everything, they had been able to place £47,414 to the credit of the reserve fund, the total of which, after deducting the £7,500, it was now proposed to withdraw, would be £56,181, compared with £17,932 a year ago. Other reasons had also actuated them in the matter. For instance, the receipts of the Platino Company—which were practically theirs, because they came to them in the shape of dividends—together with their own receipts, showed an improvement in the current half-year of about £21,500, although the connection he had spoken of with the Argentine territory was not re-established until August 9th, and although the modified collection introduced on July 1st by the Brazilian Government, under the Telegraph Convention, was considerably under the amount calculated to produce the par of exchange. It was true that this was increased on October 1st, but even with that increase the amount still fell short of the sum which would be required to give them the par of exchange, as demanded by the Telegraph Convention. There was another crumb of comfort. They were informed that measures were to be laid before the Chambers of Brazil for the application from January 1st next to the internal traffic—which was a very large proportion of their business—of somewhat similar measures to those that were being applied to the international traffic; in other words, to level up all round. The tariffs had hitherto been so low that the lines had been crowded, and the expense of working had been considerable, whereas the revenue had been extremely small and disappointing. They believed that when they were able to follow measures that were adopted in Brazil of raising their rates correspondingly, and in somewhat similar proportions to those which the Government might introduce, their revenue from the traffic would decidedly increase. In these circumstances the board believed that the shareholders would approve their action in supplementing the amount available for dividend by taking the sum mentioned from the reserve fund. He concluded by moving the adoption of the report and the payment of the dividend recommended.

Mr. John Coppen seconded the motion.

The Chairman, in answer to Shareholders, said that during his absence, and that of Major Wood, Mr. Cunningham (the secretary) had very efficiently represented both of them. Negotiations had been going on with the Brazilian Submarine Company for a closer working arrangement, and they had not been very far apart, but they thought that they were entitled to somewhat better terms than had been offered to them in view of their rising revenue and improved prospects.

The report was then unanimously adopted.

Venezuela Telegraph Company, Limited.—A meeting of the above company was held at the offices of Sir Douglas Fox, 28, Victoria Street, S.W., on Thursday morning, but a representative of the Electrical Review was informed that the meeting was private.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in Chelsea Electricity Supply Company, Limited—Provisional certificates for 8,000 ordinary shares.

Willans & Robinson.—The registers of debenture stockholders and of transfers is closed prior to the payment of interest from Tuesday last to 29th inst.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 14th, 1897, **were £1,081; week ending** November 15th, 1896, **£1,078; increase, £3; total receipts for half-year, 1897, £18,661; corresponding period, 1896, £18,825; decrease, £164.**

The Liverpool Overhead Railway Company. The receipts for the week ending November 14th, 1897, **amounted to £1,283; corresponding week last year, £1,143; increase, £140.**

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 13th, 1897, **after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,127.**

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Nov. 10th.	Closing Quotation, Nov. 17th.	Business done during week ended November 17th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	101 105	101 –1 5	..	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5⅛ – 6⅛	5⅛ – 6⅛	6	5¾
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	57 – 59	58 – 60	58	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	104 – 105	104 – 105	105½	104
3,038,920£	Do. do. Defd.	Stock	...	...	...	12¼ – 12⅝	12¼ – 12⅝	12⅝	12 9/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	16 – 16½	16 – 16½	16 7/16	16⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	114 – 118	114 – 118	...	
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3¼ – 3⅜	3¼ – 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	185 – 190	182 –187	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 –107	105 –107	106½	106
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	7/16 – 9/16	7/16 – 9/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½ – 9½	8½ – 9½	9⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ – 19½	18½ – 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 – 5	4 – 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 – 11	10 – 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 –106 %	103 –106%	...	
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10¼ – 10⅜	10 – 10⅛	10¼	10⅛
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 – 17½	17 – 17½	17½	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 – 19	18 – 19	18 11/16	18¼
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 – 104	101 –104	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	131 –134	131 –134	132	131½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7½	18 – 18½	18 – 18½	18½	18 3/16
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 –104	100 –104	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 –104	101 –104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	131 –134	131 –134	131½	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 –104	100 –104	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 –104	101 –104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 –106	103 –106	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 –111 %	108 –111%	...	...
180,227£	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½ – 12	11½ – 12	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17 – 17½	17 – 17½	17½	17¼
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	10%	26 – 27	26 – 27	25½	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 –105	102 –105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	53 – 56	52 – 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 –110	107 –110	109	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 – 2¼	2 – 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅛ – 6⅜	6⅜ – 6⅝	6⅛	6¼
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 – 17	15 – 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 – 16	14 – 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 – 6½	6 – 6½	...	...
130,766	Do. do. Nos. 119,235 to 250,000, £4 paid	5	...	...	...	4¾ – 5¼	4¾ – 5¼	4 15/16	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 –109	104 –109	106	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4¼%	5 %	5 %	9/16 – 11/16	9/16 – 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 –110	107 –110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 – 8	7 – 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 –141	136 – 141	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¾ – 4¼	3¾ – 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	102 –107	102 –107	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	4½ – 5½	4½ - 5½	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 –106	103 –106	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9 – 9½	9¼ – 9⅜	9½	9¼
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7¼ – 7⅜	7½ – 8	7⅝	7 7/16
33,129	Do. do. do. Def. Ord	7½	1 %	1 %	...	2 – 2½	2¼ – 2⅜	2½	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 –109	106 –109	...	...
88,321	West India and Panama Teleg., Ltd.	10	1/16	1/16	1 %	5/8 – 7/8	3/8 – 5/8xd	9/16	7/16
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	9¼ – 9⅜	8¼ – 8⅜xd	9	8¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	7 – 8	5 – 7 xd	6½	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	107 –110	107 –110	108⅜	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	103 –107	103 –107	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 –105	100 –105xd	102¼	102⅛

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12 – 13	12 – 13	12⅜	12⅛
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 – 6¼	6 – 6¼	6¼	6 1/16
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	10 – 10½	10¼ – 10⅜	10 7/16	10⅛
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	110 –113	112 –115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	25 – 26	27 – 28	27⅞	26
10,000	Do. do. Prov. Certs.	5	...	...	...	24 – 25	26½ – 27½	27⅜	25⅞
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 – 18	17 – 18	17⅜	17⅛
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 –136	131 –136	132½	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12⅝ – 13⅛	13⅛ – 14	13 13/16	12⅜
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	...	6 %	6 %	15½ – 15⅝	15½ – 15⅝	15 11/16	15 9/16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 – 9½	9½ – 9⅝	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	10⅝ – 11⅛	11 – 11½	11½	11
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	17½ – 18½	18 – 19	18½	18
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	17 – 18	17½ – 18½	18⅝	...
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 –123	119 – 123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15½ – 16½	15½ – 16½	16½	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	16 – 17	16½ – 17½	17	16⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½ – 10½	10 – 11	10 7/16	10 1/16
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	103 –106	103 –106	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	1⅜ – 2¼	2 – 2¼	2 3/16	2 1/16
67,900	Westminster Electric Supply Corp., Ord., 101 to 68,000 ...	5	5 %	7 %	9 %	14½ – 15½	14½ – 15½	15⅝	14⅜

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.		Closing Quotation Nov. 10th.	Closing Quotation, Nov. 17th.	Business done during week ended Nov. 17th, 1897. Highest.	Lowest
20,000	British Electric Traction	10	...	...	...	12¾— 13¼	12⅝— 13¼	...	...
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	8	2½%	...	...	1⅛— 1⅜	1⅛— 1⅜	1⅛	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅞— 2⅛	1⅞— 2⅛	2	...
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	107 —111	107 —111	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	98 —102	98 —102	101	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	9⅞	...
143,106	Do. do. do. £6 paid	10	...	...	...	5½— 6	5½— 6	5⅞	5⅝
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1 — 1½	1 — 1½	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4 — 4½	3⅞— 4¼	...	...
630,000	City and South London Railway	Stock	1½%	1⅝%	1⅝%	69 — 71	69 — 71	70½	69
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 2	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	5½%	2¼— 2⅜	2¼— 2⅜	2½	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	5½%	4 — 5	4 — 5	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	1⅞— 2⅛	2 — 2⅛	2 1/16	2⅛
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	3⅛— 3⅜	3⅛— 3⅜	3⅛	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅛— ¼	⅛— ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅛— ¼	⅛— ¼	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	8 %	10 %	19½— 20½	20 — 21	20½	20 1/16
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	110 —115	110 —115	114	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21¼— 22½	22	21⅝
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅜%	2⅜%	11½— 11⅝	11 9/16— 11 11/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	37⅛	37⅜
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	12½— 13	12½— 13	12⅞	12½

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1896.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1893—7½%; 1896—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9½.

Electric Construction Corporation, 6 % Debentures, 104—107.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 14—14½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 2—2½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

By C. H. Wordingham, A.M.I.C.E., M.I.M.E., M.I.E.E.,
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The nature of the problem of distributing electrical energy has, during the last few years, undergone a complete change. When the first attempts at supply were made, there was usually one of two distinct classes of demand to be met. There was either a cluster of consumers taking a fairly large amount of energy, gathered together in a small compact area, or a number of isolated consumers scattered over an extended area, with long distances intervening between them. Low pressure supply was obviously the best in the one case, high pressure the only possible in the other. This sharp contrast between the two classes of demand led to the independent development of the two systems of supply. Each manufacturer devoted himself chiefly to one or other, and thus, unconsciously perhaps, acquired a strong bias in favour of the system he affected, since it was necessarily to his interest that it should be used. The strange spectacle was then presented of two actually hostile camps of engineers, each proclaiming that his own system, or perhaps party would not be an inappropriate word, was the best under all circumstances, and his adversaries were devoid of all understanding. The high pressure party flattered themselves that they were the most far-seeing, while the low pressure boasted that they alone conducted their work on commercial lines, the other party being merely enthusiastic visionaries.

It is impossible to force one unvarying system on varying conditions, and hard fact overcame, as it always must overcome, prejudice, and as time went on, the high pressure party had to admit that in small compact districts their rivals were far more successful than themselves both financially and from an engineering point of view; while they had the satisfaction of seeing the low pressure party compelled to adopt high pressure as the area of their operations extended. It is to be feared even now this controversy is not quite defunct, but it is far less bitter, and cannot fail shortly to disappear.

Improvements in consuming devices and the cheapening of supply have caused the intensity of the demand, that is to say, the quantity of energy demanded per mile of main to become already very great, and in the near future there can be little doubt that it will be enormously increased, while at the same time the area to be supplied is increasing by leaps and bounds, hence it is clear that the problem now is not comprised in either of the two classes above referred to.

Of course, there will always be a certain number of towns in which owing to local circumstances, there can never be a large demand for electric or any other form of energy, and in which distribution, in the sense in which the word is used of a large city, will never be required, but in towns of any pretence to large size, it seems abundantly clear that there will have to be given a supply of electrical energy in large quantities over extended areas for every variety of purpose, whether it be lighting, heating, power or electro-chemical or other industries. This paper is not concerned with exceptional cases, it being directed to the requirements of cities and towns of considerable magnitude.

Now in such towns it appears to the author indisputable that there should be a low pressure network to which consumers can be connected directly without the necessity for any intervening apparatus on their own premises, and to which such connection can be made at all times without interfering with the supply to other consumers in any way. In his opinion it is equally essential, though he is well aware that it will by no means be universally admitted, that the current supplied to consumers should be continuous and not alternating. This opinion is based upon the fact that for all purposes of consumption continuous current is as good as alternating, with perhaps the solitary exception of some processes of electric welding, while it is undoubtedly superior to it for arc lamps, and for motors in which a variable speed is required, while for certain purposes, such as electro-plating, charging secondary batteries, and certain electro-chemical industries, it is indispensable. The superiority of continuous current for arc lamps may be challenged, but what better evidences can be adduced than the fact that most stations giving an alternating supply either employ rectifiers for their street lamps, or run continuous current generators for that purpose.

So far the consumer's aspect of the question only has been put forward, but considered from the point of view of economy and convenience of supply, there are equally cogent reasons in favour of continuous current. In the first place it admits of the use of batteries, and so enables the load on the generators to be equalised over the 24 hours, and also relieves them from momentary shocks when many motors are at work, securing also better regulation of pressure. It may be argued that with alternating systems batteries can be used through the intervention of a motor generator, but for maximum economy it is essential that they should be kept as close to the con-

* Read before the Northern Society of Electrical Engineers, November 8th.

sumer as possible in the chain of transmission. And, moreover, the capital cost of batteries is already high enough without adding the cost of an equivalent capacity of motor generators. It may, indeed, be argued that batteries are at present too costly to admit of their use on a sufficiently large scale, but the obvious reply is that even if this be so at present, the system should be so laid down as to admit of their use later on if, as can hardly be doubted, the cost should be reduced by improvements or discoveries.

In the author's opinion, the ideal to be aimed at in central station work is the cultivation of a long hour load from consumers, and the provision of a battery large enough to keep a good proportion of the generating plant economically employed during the night, and to take the whole of the peak or temporary excess over the all-day load, during the afternoon and evening.

Facilities for the use of batteries are not the only advantage of continuous current. By its use the choice of mains is left quite unrestricted, since the only loss in the conductors is that due to resistance, and there is no danger of causing disturbance to telephone lines. The importance of this is great, for when alternating currents are used it is usually, though not universally, considered that concentric cables are essential. Now, without disputing for a moment that connection can be, and is, made to such mains with the current on, it can hardly be denied that separate cables are much more easily and safely dealt with, besides which, it surely is undesirable to cut one or two of the main conductors every time a T-joint is made. That these objections are real is shown by the recent adoption by a few engineers of a cable composed of three separate ordinary cables laid up together within a lead case, though the author is not aware whether such a cable has been found to be equivalent in all respects to a concentric cable. Whether this be so or not, it is clear that with alternating current there cannot be used a system of mains which has proved to be one of the most satisfactory and durable in existence, viz., bare copper.

The vibration inseparable from alternating currents gives rise to troubles from which continuous current apparatus is free. Thus, fuse connections are apt to become loose, causing the fuse to go unnecessarily, and clamped connections of all kinds cannot be relied upon so confidently as in the case of continuous current.

There is yet a further respect in which alternating current distribution is at a disadvantage, and this is in the question of meters. Owing to the impossibility of employing permanent magnets, it is necessary to resort to an electro-magnet in order to ensure the instruments starting with small currents, and this leads to waste of energy. When inductive circuits have to be supplied, additional difficulties are met with in ensuring accurate measurements.

It must be clearly understood that the author is only advocating the use of low pressure continuous current on the distributing network. How that network is to be fed is dependent absolutely upon local conditions. It may be best if land can be obtained at a reasonable price, and if there are facilities for cheap coal and condensing water, to have several low pressure stations, or it may be preferable to establish one low pressure station for the densest portion of the area, and one high pressure station for the remainder. Or again, the character of the demand may be such as to give rise to material benefit by throwing the whole load on one or two high pressure stations. There are many considerations which enter into the question, and it would be idle to say that any particular system is best under all circumstances. The cheapest and best system to be adopted cannot be settled *à priori*; the point which it is desired to emphasise is that this is simply and solely a question of feeding the network, and that the network *qua* network can be considered by itself and on its own merits. The feeders may be low pressure ones emanating from many low pressure generating stations, or they may be supplied from a number of sub-stations in which continuous current generators are driven by motors fed at high pressure with either continuous or alternating current. The author is strongly of opinion that single phase alternating current is less suitable for this purpose than either continuous or multiphase, and he believes that it will ultimately pass out of use entirely, but as to the relative merits of multiphase and continuous currents he does not wish to offer an opinion at the present time.

Assuming that it is admitted that the distributing network can be discussed on its merits, the first point to consider is: What should be the pressure of supply to consumers? and intimately connected with this the further question: Should the system of mains be 2-wire, 3-wire, or 5-wire? Now, here again local considerations must to some extent enter into the question. Undoubtedly the pressure on the network should be as high as is consistent with safety, with the fulfilment of the Board of Trade regulations, and with economy to the consumers as regards lamps and apparatus. This Society has already had very ably put before it the case for 200-volt supply, and every day strengthens this case by the invention of improved apparatus for use in connection with it. It may be taken that a 200-volt supply is most suited to the requirements of the majority of districts, but in streets where there are a number of small shops where two small arc lamps would be readily taken up, while four would be prohibitive in price, and where the first cost of the lamps is a material consideration, the author ventures to think that it is still advisable to supply at a pressure of 100 volts. This pressure also is undoubtedly advantageous where very small motors are required, while it possesses the further advantage that at the present time, when a large number of private plants are still in use, it greatly facilitates the changing over of the installation to the town mains.

Two-wire has apparently nothing but simplicity to recommend it in preference to multiple-wire distribution, and in point of fact it is now but little used. Into the advantages of multiple wire it is not necessary here to enter. All persons appear agreed that 3-wire is best suited for the work.

The author may perhaps, however, be allowed to refer to the 5-wire system. This, as all are doubtless aware, is in use in Manchester alone in the United Kingdom, hence, few English engineers have had experience of it. There can be no doubt that its use requires a considerable amount of care in the balancing of consumers, but, provided that this point is attended to, it may be said, after just four years' experience, to be entirely successful, and the author is strongly of opinion that had it not been for the introduction of the 200-volt lamp, this system would have been adopted in all those towns in which a 3-wire supply is given, and which have recently changed over to a declared pressure of 200 volts. It may be observed in passing that had this been done there would have been far less difficulty in making the change. The advantages of doubling the pressure of supply are so obvious, and the readiness of all engineers to profit by the experience of others is so universal, that there can be little doubt on this point. Even now the five-wire system cannot be said to be defunct, for, as pointed out above, it is still desirable to supply in certain cases at a pressure of 100 volts, but that it will ever be adopted on a large scale, now that 200 volt lamps have been introduced, is extremely improbable, unless indeed the Board of Trade should be persuaded to raise the limit of low pressure to 800 or 900 volts, which it is to be devoutly hoped it will never be induced to do.

In deciding the question of the pressure to be declared, it is important to bear in mind the interests of consumers and of manufacturers. Two arc lamps can be made to burn well in series on a 100-volt circuit, and it appears extremely unfair to consumers to declare a pressure of, say, 115 volts, and condemn them to waste in useless resistance 12 or 14 per cent. of the current taken by the arc lamps. Again, manufacturers incur considerable hardship, which they naturally pass on to their customers in the form of enhanced prices, by being compelled to hold a large stock of lamps of different voltages. It should be decided once and for all what is the best pressure for general supply, and this pressure should be adopted by all towns in the kingdom. Lamps could then be standardised, and not more than three or four pressures would be required. The author would venture to suggest that the best pressures are 100 and 200 volts for lamps and small motors, and 400 volts for large motors. This question of uniformity is one of vital importance at the present time when production is so much hampered by labour disputes, and the author hopes to refer to it elsewhere more fully than could properly be done in connection with the present subject, and before a purely engineering society.

In multiple wire distribution the point to which most careful attention must be given to ensure successful supply is the balancing of the various consuming devices. This matter does not appear to be generally well understood. Many persons appear to think that if the current issuing from the station through the middle wire is small, the balancing is good. There could not be a greater mistake. Undoubtedly, if this current is large, the balancing is bad, but even if it be nil, the local balancing may be extremely uneven, and in consequence the pressure also. It is essential that so far as possible each street should be balanced in itself, and further than this, every consumer having a fairly large installation should have that installation split up and balanced in itself; in this way, and in this way only, can a satisfactory supply be given on the three or five-system. In spite of all precautions, however, there must always be some want of balance, the amount and direction of which will vary from hour to hour. This may be dealt with either by having multiple wire feeders, or by the employment of balancing motor generators; the former method appears to be the more popular abroad, and the latter in England. In the author's opinion the latter is by far the most satisfactory, as being the most simple, less costly, and as securing better compensation for want of balance.

The next point to be settled is: should there be one network for the whole city, or should there be a number of isolated networks? The argument in favour of one network is very strong. By interconnecting all points as far as possible, and by joining up every street at both ends, there is established as it were a conducting sheet on each pole from which current can be drawn, and if the demand is excessive at any one point the supply can flow to that point from all directions. The importance of this is great, for it is within the experience of every supply engineer that it is impossible in laying distributing mains to avoid occasionally under-estimating the demand in a given street. If these distributors are connected at several points to the rest of the network this is of little moment. Moreover, the area of maximum demand is constantly shifting from hour to hour, and with such a network as that advocated less copper is required to deal with this than with a number of isolated networks, each of which must be large enough for its own maximum. Again, if the position of the demand has not been accurately foreseen, and the feeding point has not been placed in exactly the right spot, the error is practically eliminated by the network. With such a system also, there is much less chance of being unable to reach a consumer in case of a fault.

Against these advantages, there would be nothing to urge if one could be certain that the insulation of the mains would continue intact, but the best of mains will fail sometimes, and it may then be urged that the consequences are much more far-reaching than if there are a number of small independent networks. In point of fact it is a question of the best means of maintaining continuity of supply. If it were feasible to arrange an automatic cut-off, whether in the form of a fuse or a mechanical circuit breaker, so as to isolate any section of mains which become faulty, there would be no question that one network is preferable, but unfortunately such a system of cut-outs is practically impossible at the present time. For imagine a complicated network arranged with a cut-out on every section of main, and suppose a short circuit on a given section, this short circuit would allow a large quantity of current to flow for a short time. If all was in order, the circuit breakers on that section of main would be thrown, but in order to throw these circuit breakers large currents must have flowed through other portions of the network in order to

reach this section, with the inevitable result that if the circuit breakers are set to cut off with extra current, they also are thrown, and the unfortunate engineer finds himself in the position of having perhaps a dozen cut-outs gone out of several hundred, with but a slight clue as to where these cut-outs are, as the course taken by the current will vary according to the conditions of the load at the time.

If the question once be faced that a short circuit cannot be efficiently provided against by means of cut-outs, but has to be burned out, then the advantages of a large network become manifest, for the relative importance of a short circuit diminishes as the extent of the scale of operation increases. Consider the case of a station supplying half a million lamps, and distributing at 400 volts. When all lamps are alight their combined resistance between the outer conductors is only about one four-hundredth part of an ohm, and it must be an extremely bad short circuit which has, and can maintain, as low a resistance as this. There is a good chance of burning out a fault quickly if the network will admit of heavy currents being delivered at any point.

In connection with the burning out of faults, it may be interesting to note that a cable is seldom burned out by fusion through excess of current. What really happens in the case of a short circuit is that an arc is established between conductors of opposite polarity, and this arc melts the conductors. If these are so enclosed that a supply of air cannot be kept up, the arc is soon choked out; the current required to burn out the fault is very much less than would be necessary if the cable were heated by the simple passage of current through it.

With a network so connected up, it is essential that means should be provided for conveniently, quickly, and safely disconnecting any section while alive, either for testing purposes or for isolating a faulty main. The author has devised a piece of apparatus for this purpose called a pillar distributor, which appears to fulfill the necessary conditions.* There are at the present time about 60 in use on the Manchester network, and the results have been extremely satisfactory. Connections and disconnections are frequently made with these pillars while the current is on, but there has never been a short circuit or mishap with them, although in one case 1,700 amperes at 200 volts was broken, and in another the current flowing at a pressure of 150 volts through a dead short circuit was also successfully broken.

The author's opinion is that in the case of a large city there should be only one network, but that this should be subdivided into a number of smaller networks connected together at certain definite points. At these points should be fixed either automatic switches, or, perhaps preferably, switches operated electrically from the generating station, which in the event of a fault on any one section would immediately isolate it, leaving it however connected to the generating station, so that it is left to the discretion of the engineer in charge as to whether the supply shall be cut off from this section or not.

It may be of interest to the Society to know what is the nature of the network in Manchester: this is shown in the diagram on the wall. Three of these networks are already connected direct to the generating station, while the fourth will shortly be so connected. The various networks are all united together at a fair number of points. These points will ultimately be somewhat reduced in number, and if satisfactory switches can be devised, they will be fixed at these points for use in the manner described above. Each network can be split up, and every length of main isolated by means of pillars. In connection with the question of balancing, there are at present four sub-stations with balancing motor generators.

The determination of the size of conductors to put down is one of the most difficult problems which has to be faced. It must be recognised at once that, contrary to the case of feeders, mathematical calculation is of no avail, and the engineer has to fall back on his experience and judgment entirely; in fact, the probable demand for electrical energy in a given street, like many another engineering problem, is a matter of pure guesswork. The best practical rule in the author's experience is to settle upon certain standard sizes of main; in his own case these are $\frac{1}{16}$th square inch, $\frac{1}{8}$ square inch, $\frac{1}{4}$ square inch, and $\frac{1}{2}$ square inch, and after a careful inspection of the street in which mains are to be laid, to decide upon one or other of these, bearing in mind that it is safer to rather over-estimate than under-estimate the demand, for new developments of the uses of electrical energy are likely to lead to increased consumption, and, in a flourishing city, property tends to improve. Moreover, distributors once laid should never require to be increased in section.

In mutiple wire networks, the usual practice is to make the outer conductors larger than the intermediate, but the author prefers to keep all the same size. If this be done, and the above principle be followed, and if the network be well cross-connected as suggested earlier in this paper, it should be possible to deal with all future demands by adding to the number and section of the feeders.

Of course it will be necessary to settle upon a current density at which to aim, and the author considers 600 amperes per square inch to be suitable for the average conditions of supply.

Summarising what has gone before, we may take it that we have determined to establish a distributing network on the three-wire system, with five wires in certain streets, and to give a supply of continuous current at a pressure of 200 and 400 volts, and also in special streets when there are five conductors at 100 and 300 volts. The next point to determine is the system of mains to be employed.

Several able papers on the relative merits of different systems of mains have already been brought before this society, and the author therefore begs the indulgence of members if, in stating his own experience and opinions, he traverses ground already familiar to them.

What are the conditions which are to be fulfilled? In the first place, it is important that the mains should be so arranged that they can be tapped at any point along their length. They should not require that connecting boxes be laid down at predetermined points, for many of these will certainly be wasted, and many will be found to be in incovenient positions necessitating either the entrance of the service line at an unsuitable point in the building, or the running of unnecessarily long connections. Jointing on of service lines should be easy, quickly effected, and should not require highly trained men or special contrivances. While low first cost is highly desirable, it is of greater importance that the mains should be of durable materials, and should be unlikely to fail, for the failure of a distributing main is of much greater importance than the failure of a feeder, since it is easy and, comparatively speaking, not costly to provide reserve feeders, while it is out of the question to duplicate distributing mains. Further than this, the feeders can be readily withdrawn, while a distributor cannot be renewed without serious interruption of the supply, and excessive labour for rejointing. The insulation of conductors should be permanent and steady; it need not be extremely high. The system of distributors should be as flexible as possible, since it is always preferable to lay them under the footways and near the buildings, and many obstacles to a straight course are in consequence met with. The mains should afford security against fire, explosion, or other damage to person or property, and they should interfere as little as possible with the surface of the street or pathway. They should be unaffected by the soil, as well as by rats or other vermin.

Mains fall broadly into two systems—drawing-in and built-in.

The drawing-in system is very attractive in theory, and in practice is under certain circumstances to be preferred for feeders, but for distributors the title is a misnomer, for every drawing-in system becomes a built-in system as soon as T-joints are made to connect consumers to the conductors. It is impossible to draw the conductors out without cutting all the branch wires, and to draw in additional cables on the top of old ones is to court certain disaster, for they will assuredly damage both the branch connections and the main conductors.

If a drawing-in system be employed, each cable should be in a separate duct, otherwise should there be an earth on one cable, and the insulating covering be damaged, the fault will almost inevitably develop from an earth into a short circuit, whereas, if the cables are held apart in separate ducts, this will not take place, and the fault may be found before disaster ensues. A drawback to these separate ducts, is that they are of necessity close together, and when the main is broken into to make a branch connection, these cables are held so rigidly and so close together that it is a difficult matter to make a satisfactory joint.

Turning now to the built-in system, the conductors may either be insulated throughout with a solid dielectric, or with a solid and a fluid dielectric intimately mixed, or else with a fluid and a solid at intervals. In the former case, there will be a certain leak all along the conductor; in the latter, if the fluid be air, the insulation will be perfect except at the solid points of support.

In the first class are included solid material such as vulcanised india-rubber, vulcanised bitumen, diatrine, &c., and mixtures such as paper or other fibrous material impregnated with air or light or heavy oil.

In the second class, there is less variety, the conductor usually being supported on porcelain, the chief difference in detail being in the method of support, the conductor either merely resting on the supports, or else being tightly strained at intervals.

There is one important essential difference between the two classes; in the first, the insulation resistance is usually high, but the thickness of dielectric is very small, and if the material is defective, or is injured at any point, there is almost certain to be established a considerable leak to earth, while in the second class the insulation is much lower but the conductor, instead of being liable to leakage throughout its length, can only come in connection with earth at intervals, *i.e.*, at the supports, and the supports are of such a size that the actual distance of the conductor from the earth is considerable, and even if an insulator entirely fails, there is a good chance that it may not come in contact with earth.

Taking the first class of insulation, it would not be profitable to discuss in detail each dielectric available. When solid insulation only is employed, the dielectric is usually waterproof in itself, but when fluids are intermixed with the solids it becomes necessary to enclose the material in an impervious envelope to exclude moisture, and to retain the fluid if the fluid be a liquid. In the author's opinion a waterproof solid is preferable to the mixture, partly because it is less likely to allow water to enter, whether during jointing or if slight damage be done to the outside of the cable, and partly because the impervious envelope is usually lead, which, being very heavy, increases the labour of laying, and when laid requires a plumber to be employed whenever a joint has to be made, unless expensive and otherwise objectionable joint boxes be employed. Further than this, the lead being a good conductor, the effects of a fault are often transferred to points at a considerable distance from the original seat of the mischief.

Turning to the second class, the conductor is usually in the form of strip, since this can be readily rolled up to bring it on the ground, and it may either be supported at frequent intervals on insulators slotted to receive it, or it may be tightly stretched at long intervals, intermediate supports being provided at a fair distance apart. Unquestionably, the latter method is the best, since the number of insulators can be greatly reduced, while their shape can be made so as to give each insulator a much higher resistance.

Conductors insulated as in the first class may, of course, be used in drawing-in systems; when laid on the built-in system they are either protected with steel armouring and laid directly in the ground, or

* See Electrical Review, July 3rd, 1896.

they are placed in a trough of iron or wood, and are surrounded with bitumen, pitch, or some similar material, the additional protection of armour being used in some cases.

In the author's opinion, the best system of distributing mains is that in which bare copper is tightly stretched between porcelain insulators carried by cast-iron bearers. This system, which was introduced a good many years ago by Mr. Crompton, will be found fully described in its latest form in the appendix. A very fairly high insulation resistance is attained, higher even than is absolutely necessary. The actual result will depend largely upon the atmosphere in the culvert when the test is made. Table A gives figures under various conditions. It must be borne in mind that in most of the instances given, the insulators were reeking with moisture, the culvert being quite new, and having been closed in the instant the concrete was strong enough to bear the weight of the flags.

TABLE A.

INSULATION RESISTANCE OF STRETCHED BARE COPPER MAINS.

Length of culvert.	Size of conductor.	Insulation resistance. Of length.	Insulation resistance. Per mile.	Date culvert closed in.	Date strip fixed.	Date of test.	Weather at time of test.
Yds.	Sq. in.	Megohms.	Megohms.				
56	1	1,316	42	Feb., 1897.	Mar. 25, 1897.	May 3, 1897.	Fine—dry.
	1	390	12				
	1	351	11				
	1	164	5				
	1	211	7				
107	1	2,308	140	Jan. 23, 1897, to Feb. 2, 1897.	Mar. 23, 1897.	Mar. 26, 1897.	Damp.
	1	960	52				
	1	2,799	170				
	1	939	57				
	1	1,069	65				
89	1	67	3·39	May 13, 1897.	Aug. 31, 1896.	Feb. 1, 1897.	Very damp.
	1	56	2·83				
	1	165	8·32				
	1	9	0·43				
	1	98	4·93				
51	1	2,071	60	Oct. 27, 1896.	Dec. 4, 1896.	Dec. 8, 1896.	Fine.
	1	810	23·4				
	1	3,589	104				
	1	953	27·6				
	1	1,737	50				
85	1	3,735	180	Sept. 22, 1896.	Nov. 23, 1896.	Dec. 2, 1896.	Raining heavily.
	1	12,865	621				
	1	898	43				
	1	2,573	124				
	1	957	46				
84	1	6·3	0·3	July 29, 1896.	Sept. 3, 1896.	Nov. 27, 1896.	Damp.
	1	8·1	0 386				
	1	6·9	0·328				
	1	36·8	1·75				
	1	29·8	1·42				
82	1	103	4·7	Sept. 25, 1896.	Nov. 20, 1897.	Nov. 26, 1896.	Damp.
	1	42	1·95				
	1	5·3	0·246				
	1	23	1·06				
	1	723	33·68				
77	1	104	4·55	Aug. 10, 1896.	Sept. 4, 1896.	Nov. 25, 1896.	Damp—frosty.
	1	275	12·02				
	1	136	5·9				
	1	141	6·18				
	1	50	2·2				
85	1	3·3	0·159	Oct. 23, 1896.	Nov. 16, 1896.	Jan. 18, 1897.	Dry—very frosty.
	1	39·1	1·88				
	1	6·8	0·328				
76	1	13·8	0·595	Oct. 22, 1896.	Nov. 16, 1896.	Jan. 18, 1897.	Dry—very frosty.
	1	10·9	0·47				
	1	5·6	0·241				
58	1	349	11·4	Oct. 2, 1896.	Nov. 13, 1896.	Dec. 4, 1896.	Raining.
	1	1,944	64				
	1	53	1·74				
55	1	88	2·7	Oct. 26, 1896.	Nov. 16, 1896.	Dec. 3, 1896.	Very damp.
	1	537	16·7				
	1	618	19				

NOTE.—The above tests were made after one minute's electrification with the negative pole of a battery giving about 400 volts, the direct deflection method being employed. One division of Galvanometer scale corresponded to about 120,000 megohms.

The question will naturally be asked: What does this insulation become under working conditions? Unfortunately, it is seldom possible to make tests after a line has once got into use, but in one instance circumstances admitted of a test, particulars of which are given below:—

Culvert closed, June 16th, 1896.
Copper strip run, September 1st, 1896.
Current turned on a few days after September 1st, 1896.
(Exact date cannot be given.)
Length of culvert, 78 yards.
Current taken off and main tested, February 2nd, 1897.

INSULATION RESISTANCE OF LENGTH.

	Positive pole of battery in line. Megohms.	Negative pole of battery in line. Megohms.
Positive conductor	161·3	122
,, intermediate	73·9	57 7
Middle conductor	42·3	34·1
Negative intermediate	36·5	36·5
,, conductors	24 5	23 4

The above tests show what is almost universally found, that the insulation resistance of the negative pole, whatever the system of mains employed, is substantially lower than that of the positive pole. That of the negative, however, in this case is very satisfactorily high.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS. By L. EPSTEIN, Member. (Read November 11th, 1897.)

While electric traction on the trolley system has proved on the whole an unqualified success, both from a technical and financial point of view, traction by means of accumulators could, until quite recently, only be pronounced a failure, and all that even its most ardent advocates can plead for is the substitution of the term "qualified success." However, at the present time, signs are not wanting that promise at last success for accumulator traction. The progress made in the manufacture of secondary batteries, and the experience gained with regard to the best mode of using them, not only warrant that belief, but what will no doubt prove more convincing, relatively good results have already been obtained.

It will be remembered that ever since accumulators were produced on a commercial scale, attempts were made from time to time to use them for traction purposes; but all these experiments, up to a short time since—although frequently hailed with great enthusiasm—only led to disappointment, from a commercial point of view.

An investigation of the causes which militated against success might prove useful, and will show that they may be divided into two classes, viz., inherent defects in the accumulators themselves, and mistakes in the mode of their application.

Dealing with the method of working first, it will be seen, on analysing the expenses, that apart from the cost of repairs and renewals, a heavy expenditure was incurred by the handling of the batteries; and in view of the success of trolley traction, it is natural that the remedy should suggest itself to imitate, as far as possible, the latter system, that is to say, to employ accumulators in such a manner that they require a minimum of attendance and handling.

It was, as we all know, the common practice to sub-divide the battery into a number of groups, each contained in a tray, and the connection between one tray and the next, as well as at the terminals both on the cars and in the lifts for charging, was most imperfect. Sliding contacts were generally used, which were open to attack by the acid spray, necessitating almost incessant cleaning and repairs. Again, the pulling out and pushing in of these heavy trays was not always done with the requisite care, much to the detriment of the batteries, cars, and lifts. A further considerable source of waste consisted in the electrical leakage when charging, especially as many tiers of the cells were underground, and therefore out of sight, whilst they were not easily accessible, and were thoroughly saturated with acid spray.

These difficulties and losses can be obviated by adopting a system which will allow of the batteries being treated as a mechanically and electrically well connected whole, either by being placed in the cars or preferably slung to the frame, or carried on a separate car—apart from the sub-division in groups for coupling in parallel or series during discharge. Where the conditions of working render it desirable, the motor, or motors, could also be fixed in the battery car, which would then assume the character of an electric locomotive; but in any case, whether carried in the car itself or slung to the frame, or carried on separate wheels, the battery should not be sub-divided and handled in the old way, but should always be treated as an indivisible unit. The obvious advantages gained by this method are the absence of lifts or similar contrivances, good connection between cell and cell, no corroding contacts, no loss of current through leakage, less wear and tear of the batteries, and consequently easier management and reduced expenditure. The importance of obviating the exchanging of batteries has been fully recognised on the Continent, and the methods of working in Hanover and Paris offer interesting illustrations of how this object has been attained.

In Hanover, as is well known, a combined system of trolley and accumulators is in use. The batteries are charged from the trolley *en route*, and an additional charge is given to them on their return to the car shed. This installation is on a sufficiently large scale to render the financial results of commercial value, and it is gratifying to see from the official report that the results for the year 1896 were pronounced to be in every respect satisfactory. The cost of maintenance is said to have been accurately ascertained, and found to average per car and month 40s., which, at an average mileage of 90 per car and day, corresponds with ·177d. per car mile. The directors anticipate that this cost will be increased somewhat, but they are also confident that it will in no case exceed 60s. per car and month (which amounts to ·266d. per car mile) even in those years when the quicker deterioration of the plates will occur. It must be understood that the cost of maintenance includes renewals of plates to keep the latter always in good condition, so that the additional depreciation is reduced to a rate not higher than that of the renewal of other parts of the machinery. Based on the actual experienced gained, this rate has been fixed at 6 per cent., and with an accumulator car covering between 31,000 and 34,000 miles during the year on this mixed system, accumulator traction incurs an additional expenditure of ·4d. per car mile, as compared with the trolley. Taking into account that in the absence of the accumulators the trolley system would have to be installed throughout the whole line at an outlay of £2,000 per mile of track, and further considering the maintenance of the overhead system, and the saving in the wear and tear of the trolley, which is, of course, at rest while the accumulators are supplying the current, it is computed that even on the most unfavourable assumption the extra cost of the combined system, compared with the overhead system alone, does not in Hanover exceed ·2d. per car mile.

It may be of interest to mention here that the running expenses of the electrical system, including driver, amounted to 2·22d. per car mile.

This system, although so far satisfactory, is open to certain objections, the foremost being the dead weight of the accumulators carried on the trolley wire section. It might be found more advantageous to place the batteries in a frame slung to the car, or in dummy cars, either of which could be picked up at the end of the trolley section, while the charging of the accumulators could still be effected in the same manner from the trolley wires, the only difference being that the charging would take place at fixed points instead of *en route*.

A different system is employed in Paris, where the Société des Moteurs have installed and are working a line about 12 miles long at the same cost, including depreciation, as horse traction. Here the plan has been adopted of charging the batteries at the stopping places, the time of charging varying ordinarily between 8 and 10 minutes, and the charging is effected not, as is usual, at constant current, but at constant potential, consequently very high current densities are applied at the beginning of the charge. Six feeder circuits are projected, of which three are working at present. These circuits are underground, and although at different lengths, are all of uniform resistance. I am not aware that any figures showing the actual cost of working are available.

It will be seen that, however different these two system may be in detail, they have the following points in common:—

1. The batteries are dealt with as a whole.
2. The batteries are once for all installed in the cars where they are charged and discharged.
3. Each of the two systems permits the use of batteries of less weight than if the old practice had been followed of charging them either at the journey's end or at constant current.

Never losing sight of the object in view, viz, to approach in the mode of working, as far as possible, the overhead or conduit system, the special method to be adopted will depend upon local circumstances. While in one case the batteries may be advantageously carried in or slung to the car, in others it will be found desirable to place them in dummies, which latter might also carry the motors, as an alternative to the motors being fixed in the cars. A dummy with a battery sufficient to propel a 52 passenger car for about eight hours will weigh, complete, about 3 tons, the dummy itself, with axles and wheels, weighing about three-quarters of a ton. As each ton propelled under normal conditions incurs an expenditure of about ·4d., the extra weight of the dummy would increase the expense by about ·3d. per car mile. It is, however, obvious that this increase represents only a small fraction of the expenditure which is incurred when the accumulators are handled in the old manner, apart from the saving in wear and tear of the cars and of the batteries.

There are many lines on which the traffic varies considerably, not only as is usual during the different hours of the day, but, perhaps, in a much more marked degree, during different seasons of the year, such, for example, as tramways in market towns or seaside places. By the use of dummy cars, the exigencies of a varying traffic can most effectively be dealt with, as they may be attached to one or more trailers, provided the batteries have the required qualities, and may safely be discharged at high rates.

However excellent the method of using the battery may be, it will avail but little if the battery itself be lacking in the necessary qualities, and it may safely be asserted that the success or failure of accumulator traction will be decided by the merits of the accumulator. In order to lend itself satisfactorily to traction purposes, an accumulator must, in addition to all the good points possessed by a successful lighting cell, present special features of its own. Although lightness may not be the main consideration, yet it is a very important one. Again, the cell must not only be able to withstand jolting without shedding of material and high discharge rates without buckling; but, moreover, it must not decrease in capacity while in use, as this would necessitate alterations in the time-table relating to the charging of the batteries, and interfere with the general arrangement. The battery, furthermore, should not require frequent overhauling, and the repairs should be neither more numerous nor more costly than those of any other part of the machinery, We all know that in the past batteries left very much to be desired. Some of the positive plates deteriorated much sooner than others, and this led first to the practice of replacing them by less damaged plates taken from other cells, and finally to that of converting part of the negative section into positives. After some time the original array had dwindled down to a small fraction, consisting of the least injured remnants, which were occasionally referred to as a proof of the long life of the type they represented. As a battery naturally consists of a large number of cells, and each cell again consists of a large number of plates, the overhauling and repairing proved a very serious item—in fact, in many cases the heaviest item of expenditure.

The nearest approach to an ideal cell for traction purposes will probably be one in which the positives are of the Planté type, with a large extent of surface, the layer of active material relatively thin, but in most intimate contact with the metallic lead out of which it has been formed. As is well known, while the capacity of a plate is determined by the volume of active material, the rate of charge and discharge depends upon its surface, and as it is quite feasible by means of ribs or protrusions, without unduly interfering with the mechanical strength of the plate, to extend its area to about 10 times that of the plain surface, it follows that the current densites obtainable will be increased in the same ratio. It is further essential that the acid should have free access to all parts of the active material, and such is naturally much more the case with a Planté plate, offering a largely extended surface with a thin coating of peroxide than it would be in a plate with a plain surface, where the active material forms a relatively thick layer. Not only is the contact between active and conductive parts less perfect in the pasted plate, but in addition thereto, as the acid in the pores of the active part is liable to become exhausted, especially with heavy discharge currents, while the interstices are too narrow to allow of a quick diffusion of the electrolyte, the electric action may be seriously interfered with, although there may still be a sufficient quantity of undischarged active material.

As regards good negative electrodes, positives of the above description, after having been reduced, may be employed with advantage, or lead oxides or salts may be used, as the finely reduced lead is a much better conductor than peroxide of lead; but care should be taken to secure the best possible contact between such material and its support, and so to select the materials intended to become active that they will, after full formation, produce a layer of the highest possible porosity consistent with mechanical coherence.

It has been found by experiment that the exhaustion of a positive plate or section of a cell effects a gradual falling in the E.M.F., while as soon as the negative electrode is exhausted the E.M.F. falls very rapidly. For this reason, and as it is obviously advantageous to have as little variation in the E.M.F. of the battery as possible, I would suggest, for traction purposes, to use negative sections of higher capacity than that of the corresponding positive sections.

In the interest of economy, the formerly much-recommended overcharging must not be too freely indulged in. Such overcharging can easily be guarded against by using recording instruments, or by other suitable means, while when charging at constant potential the battery will itself guard against over-feeding by effectively opposing, at the proper time, the charging current. The recommendation to overcharge the cells *occasionally* may, however, be followed with advantage, the beneficial result consisting not so much as was formerly supposed in the actual improvement of the electrodes, but in the thorough mixing of the electrolyte, which is liable to vary in S.G., being densest at the bottom of the cell and decreasing towards the surface, thus leading to unequal action in different parts of the plate. Another device for equalising the action over the whole surface consists in making the electrodes taper towards the bottom, with the object of compensating for the higher density and better conductivity of the electrolyte there by increasing the distance between electrodes of opposite polarity.

We are now, however, confronted with the all-important question of the cost of depreciation of the batteries. If we consider a battery in a car for 52 passengers with an average running weight of about 12 tons and an average mileage of 100 per day, equal to 1,200 ton miles per day, we find that at the rate of 80 watt-hours per ton mile the daily electrical expenditure is 96 units, or, if working at 400 volts, 240 ampere-hours. It is, of course, immaterial for our calculation what the voltage is, as the cost of renewal of either a small number of large electrodes or a larger number of small electrodes will be practically the same for the watt-hour capacity. The cost of renewing the positive section of a cell of such capacity should not exceed, including manufacturer's profits, 10s., and, assuming two discharges or their equivalent a day, we may reasonably expect a useful lifetime extending over 1,500 discharges. The battery doing work, therefore, during 750 days and covering 75,000 car miles, the cost of renewing the positive sections in 220 cells will amount to £110 or ·35d. per car mile. That this estimate errs on the safe side is borne out by the experience gained in Hanover, although it seems that the batteries used there are of greater weight than is necessary.

Given a good battery and having adopted a system best suited to the conditions of a given line, and in any case obviating the necessity for handling the batteries, we should arrive at a working cost approximately the same as on the trolley system—the extra expenditure caused by the greater weight of the self-contained care being balanced, as is shown in Hanover, by corresponding advantages gained.

While on tram-lines accumulator traction must prove its superiority over rival systems in order to be adopted, there is another large field in which the use of batteries is a matter of necessity. I refer, of course, to traction on ordinary roads.

The tractive force on ordinary roads is naturally subject to much greater variations than that on rails. I think, however, that on good roads paved with asphalt or wood and in fairly good condition, the tractive force of vehicles as hitherto built should, on the level, not exceed 60 lbs. The weight of an electrical vehicle to carry from two to four passengers, with motor and battery complete, will be about 30 cwt., which includes a battery with a weight of 9 cwt. A battery of such weight ought to be sufficient to supply current for a four or five hours' run, at an average speed of 8 miles on the level and 4 miles up a gradient of 1 in 24. The power on the driving axle will be about 2 effective H.P. in the former case, and about 3 effective H.P. in the latter; and, assuming a combined efficiency of motor and gearing of 65 per cent., the battery will have to furnish discharges at the rate of 2,208 watts and 2,812 watts respectively.

With a battery efficiency of 70 per cent., the charge to supply one hour's actual run requires about 3 units, which, at an estimated cost of 2d. per unit (a sum that should certainly not be exceeded, whether the current be generated at the company's own stations, or taken from a public supply), corresponds with a cost of ¾d. per mile. It may therefore be anticipated that electric carriages plying for public hire should be able successfully to compete with horse-drawn vehicles for a similar purpose, provided that the wear and tear of the accumulators is not excessive. The favourable financial results would not be impaired even if the cost of maintaining the accumulators should exceed the rate of 10 per cent. per year, said to be quoted by some manufacturers. The time during which such accumulators have been at work is probably too short to prove whether the batteries can be maintained at such a remarkably low rate.

Reliability of the battery, obviating the necessity for frequent examinations and tests, and for remedying partial defects, is again of much higher importance than—within reasonable limits—the lifetime of the whole battery, as will become evident from the following consideration. Assuming the average mileage made with one charge to be 40, and estimating the cost of renewing the positive section at 10s. per cell, or £20 per battery of 40 cells, the cost of renewal per mile would be as follows:—

If renewed in 8 months = 240 days, after 9,600 miles, ·5d. per cab mile.

If renewed in 12 months = 360 days, after 14,400 miles, ·33d. per cab mile.

If renewed in 16 months = 480 days, after 19,200 miles, ·25d. per cab mile.

If renewed in 24 months = 720 days, after 28,800 miles, ·166d. per cab mile.

If the average cost of a battery be £60, and if it should become necessary to renew all the positive sections—even after as short a time as 12 months, after having run 14,400 miles—it is true that the cost of renewals (£20) will equal 33⅓ per cent. of the first cost, but this only equals one-third of a penny per cab mile. On the other hand, even with batteries having a longer life, but necessitating supervision and slight repairs, the wages incurred and the cost of material would, judging from the experience gained in tramway work, certainly amount to a much larger sum than the cost incurred in renewing the positive sections, even in a comparatively short time. Besides, in such case, more sets of batteries per car would become necessary, increasing not only the first outlay, but the charge for interest and depreciation, and thus considerably swelling the total cost.

Lightness of batteries for ordinary roads is of much more importance than it is on tramlines, not only on account of the heavier energy expenditure which is necessary to propel a given weight, but the more so as the battery will represent a larger portion of the total weight of the vehicle as compared with tramcars. In large towns it would be an advantage to use batteries which are interchangeable, and to make arrangements with public supply companies to charge the batteries and always keep a number ready for use

The drivers would then be able to exchange the batteries at the nearest station instead of being compelled to return to the one station, which may be a long distance off; time would thus be saved, and the earning capacity of the electric carriages increased.

The figures relating to tramways contained in this paper are the results of my own tests; but such is not the case with those having reference to traction on ordinary roads. I should have preferred to submit data, based on personal observations on a motor car which I am making, and which I think embodies several improvements tending to reduce the necessary tractive force. But unfortunately, as is often the case with new constructions, the completion of that car has taken longer that anticipated, and, although I endeavoured to postpone my paper until I should be in a position to bring something which might have the charm of novelty before this Institution, yet, wisely or otherwise, I gave way to the request to read a paper on electric traction at the beginning of the session. If—as I fear—I have failed to bring anything very original or interesting before you, this must be my excuse.

Physical Society.

Ordinary meeting, November 12th, 1897.

Mr. G. Johnstone Stoney, Vice-President, in the Chair.

Mr. J. Rose-Innes read a paper on The Isothermals of Ether.

Mr. W. L. Waters read a paper on the Variations in the E.M.F. of the H-form of Clark Cells with Temperature.

The authors, Messrs. F. S. Spiers, F. Twyman and W. L. Waters, have investigated how nearly the true E.M.F. of Clark cells can be computed at different temperatures by applying the ordinary temperature correction. As a standard, two cells of the Muirhead type are employed. The four cells under test could be put through cycles of temperature in a special heating bath, containing oil circulated by a centrifugal pumping vane. E.M.Fs. were determined by a potentiometer method, and a careful study was made of the "lag" of E.M.F. behind temperature. The results are given in the form of curves. It is shown that "lag," in the H-form of cell, is less than in the "Board of Trade" form. Under ordinary conditions, when the rate of variation of temperature is less that 2° C. per hour, by applying temperature corrections the true E.M.F. of the H-form can be found to within a ten-thousandth of a volt. In this respect there is little to choose between the H-form and the "Muirhead" cell.

Mr. W. R. Cooper thought the authors did not express the case clearly. The E.M.F. of the "Board of Trade" cell could not, with reason, be itself stated within 1 per cent. But in some cases, when, for instance, cells were used differentially, greater accuracy might be required, as, for instance, when a constant source of E.M.F. was being compared with the variations of another source. Here it might be necessary to know the "lag." He would like to know with what degree of accuracy the E.M.F. of the standard cell was determined by the authors. The "lag" that occurred in the "Board of Trade" cell was probably due to diffusion, crystallisation, and solution.

Mr. Walter said the E.M.F. of the standard was measured by a Kelvin balance to one in ten thousand.

The Vice-President proposed votes of thanks to the authors, and the meeting adjourned until November 26th.

ON A DETERMINATION OF THE OHM MADE IN TESTING THE LORENZ APPARATUS OF THE McGILL UNIVERSITY, MONTREAL.

By Profs. W. E. AYRTON, F.R.S., and J. V. JONES, F.R.S.

This apparatus, made by Messrs. Nalder Bros., is in general arrangement and dimensions similar to the Cardiff apparatus described in the *Philosophical Transactions* of the Royal Society, 1891, A., pp. 1—42, and in the *Electrician*, June, 1895, Vol. xxxv., pp. 231 and 253.

The field coil, in pursuance of a suggestion contained in the Royal Society's paper, consists of a single layer of wire wound in a helical groove of semi-circular section, cut in the cylindrical surface of a massive marble ring of about 21 inches outside diameter, 15 inches inside diameter, and 7 inches thick. This helical groove has 201 complete turns, with a pitch of 0·025 inch. Bare wire, of mean thickness 0·02136 inch, was first used, and the outside diameter of the coil so wound was measured in the Whitworth machine with the following results:—

Diameter.	Near front face.	Near middle.	Near back face.
0° — 180°	21·04722	21·04765	21·04765
10° — 190°	21·04795	21·04765	21·04952
20° — 200°	21·04768	21·04755	21·04905
30° — 210°	21·04805	21·04745	21·04818
40° — 220°	21·04785	21·04755	21·04825
50° — 230°	21·04808	21·04730	21·04812
60° — 240°	21·04752	21·04755	21·04805
70° — 250°	21·04755	21·04775	21·04822
80° — 260°	21·04785	21·04795	21·04895
90° — 270°	21·04812	21·04780	21·04942
100° — 280°	21·04805	21·04815	21·04925
110° — 290°	21·04808	21·04825	21·04898
120° — 300°	21·04785	21·04840	21·04905
130° — 310°	21·04828	21·04835	21·04915
140° — 320°	21·04828	21·04815	21·04908
150° — 330°	21·04805	21·04805	21·04932
160° — 340°	21·04872	21·04795	21·04858
170° — 350°	21·04778	21·04785	21·04812
Mean	21·04797	21·04784	21·04872

General mean = 21·04818 inches.

The temperature, which was taken at each observation, varied between 19·9° C. and 21° C., and had a mean value of 20·4° C. Correcting for the difference between the temperature at which the bars of the Whitworth machine have their specified value and this mean temperature, we have for the mean outside diameter of the coil when wound with bare wire 0·02136 inch thick.

21·04932 inch at 20·4° C.

From the above measurements it is clear that the wire lay on a very true circular diameter. With bare wire, however, of the thickness used it was found impossible to obtain sufficient insulation between pairs of convolutions. Hence, after much time had been spent in endeavouring to insulate the successive turns by forcing paraffin wax in between them, &c., the coil was unwound and rewound with double silk-covered wire which had been first dried, then drawn through paraffin wax, and, lastly, baked before the winding was commenced. To wind so large and heavy a ring was not an easy matter, and it was not until the winding had been performed three times that the layer looked sufficiently uniform and quite free from abrasion of the silk.

The mean thickness of the double silk-covered wire used in the last winding was 0·01914 inch, so that the outside diameter of the wound coil, calculated from the value given above for the coil wound with bare wire was

21·04488 inches at 20·4° C.

The coil was then brushed over with melted paraffin wax, bound round with silk ribbon that had been soaked in a solution of shellac, and finally loosely covered up with a wide silk ribbon that had been passed through paraffin wax.

During the time that the ring was unwound the linear coefficient of expansion of the marble was measured by Messrs. Spiers, Twyman and Waters, three of the students of the City and Guilds Central Technical College. The experiment was attended with difficulty, for it was far from easy to bring so large a mass of a badly-conducting substance to the same temperature, but ultimately the result 0·000004 per 1° C. was obtained.

At the conclusion of the resistance observations, recorded farther on, the silk ribbons and the protecting layer of paraffin wax were carefully removed until the silk covering of the wire appeared, and the diameter of the coil was measured along two directions at right angles to one another. The maximum difference between four measurements was only five hundred thousandths of an inch, and, after the introduction of the proper temperature corrections, the mean value of the outside diameter of the coil was found to be

21·04687 inches at 20·4° C.

This result is about one part in ten thousand larger than the calculated value given above, and the difference is probably due to the silk covering of the wire having swollen slightly when the wound coil was brushed over with melted paraffin wax. In the calculation, therefore, of the coefficient of mutual induction we have considered it more accurate to use the value obtained by direct experiment. Subtracting from that value—21·04687—the thickness of the double silk covered wire—0·01914—we have for the mean diameter of the coil *from axis to axis of the wire*

21·02772 inches at 20·4° C.

Shortly before the last set of resistance measurements was carried out the edge of the phosphor bronze disc was ground in position so as to be made quite true with the axis of rotation, and immediately after the completion of the measurements the diameter of the disc was measured and found to be 13·01435 inches at 19·5° C. Messrs. Spiers, Twyman, and Waters had previously determined its linear coefficient of expansion to be 0·0000125 per 1° C., so that its diameter was

13·01451 inches at 20·4° C.

During 1896, when Mr. W. G. Rhodes was an assistant at the Central

Technical College, he carried out the long calculation of the coefficient of mutual induction between the coil, as wound with bare wire, and the disc, by using the method given in the paper on the *Philosophical Transactions* above referred to, and with the following values:—

Diameter of coil		or $2A$ =	21·02673 inches.
„ „ disc		„ $2a$ =	13·01997 „
Axial length of helix		„ $2x$ =	5·025 „
Number of convolutions		„ n =	201

he found M = 18,056·36 inches.
= 45,862·33 centimetres.

This calculation was checked by Mr. Mather, and independently by one of the authors.

Now it can be shown that for the above values of A, a, x, and n

$$\frac{d\,M}{M} = 1{\cdot}246\,\frac{d\,A}{A} + 2{\cdot}346\,\frac{d\,a}{a} + 0{\cdot}0997\,\frac{d\,x}{x},$$

and so the value of M for the particular values of $2A$ and $2a$ given above, viz., 21·02772 and 13·01451 can be calculated. When this is done we find M = 18,037·51 inches.
= 45,814·45 centimetres.

and this was the value of M which we employed in our final determination after allowance had been made for the effect of the central brush, as will be described further on.

The accuracy of the preceding calculations was tested in the following way:—Values of $2A$ and $2a$ differing slightly from those employed by Mr. Rhodes were selected, and by means of the formula for $\frac{d\,M}{M}$ the proportional change in M was determined by Mr. Twyman. Then the value of M for these changed values of $2A$ and $2a$ was calculated by the authors from a new formula involving an elliptic integral of the third kind.*

The centre brush consists of a tube 0·135 inch outside diameter, which projects into an axial hole in the disc of 0·144 inch diameter. Contact with the edge of the disc is made by three small tangential phosphor bronze tubes lightly pressed on it, at points separated by angular distances of 120°. Through all four tubes a small stream of mercury is kept flowing, as this is found to greatly diminish the disturbances caused by variations in the thermo-electro effects, and the employment of three brushes at the circumference, as suggested by Rowland, eliminates small errors due to imperfect centering of the coil and disc.

To prevent the mercury which drops out of the central tube-brush touching the disc at a larger radius than that of the hole in its centre, an ebonite boss is cemented to the disc, and this causes the mercury to drop away quite clear of the metal of the disc.

If we take as the effective outside diameter of the central tube 0·139 inch, that is the mean of 0·135 and 0·144 inch, calculation shows that the coefficient of mutual induction is reduced by 4·50 centimetres, so that finally we have

M = 45,809·95 centimetres.

As the allowance for the central brush only diminishes M by one part in ten thousand, it is clear that for that degree of accuracy an error of a few per cent. in estimating the diameter of the central brush is of no consequence.

The method of making the observations was the same as that described in the papers on the Cardiff apparatus read before Section A of the British Association at Nottingham and Oxford (*vide* Report of the Committee on Electrical Standards, Appendices 1893 and 1894). The use of an extremely sensitive Ayrton-Mather galvanometer of the d'Arsonval type, materially facilitated the readings being taken. Two such narrow coil galvanometers were specially constructed by Mr. Mather himself for use with the Lorenz apparatus, and the data of the second instrument are contained in the following table.

Resistance of suspended coil ...	...	1·9 ohms.
„ coil and suspension	...	5·75 „
Periodic time of complete swing	...	7·6 seconds.
Scale distance actually used ...	...	1,412 millimetres. / 1,340 scale divisions.
Deflection in divisions at actual scale distance used		137 per micro-ampere. / 23·8 per micro-volt.
Deflection in divisions at scale distance equal to 2,000 scale divisions	...	204 per micro-ampere. / 35·8 per micro-volt.

The resistance coils used were those previously employed in the Cardiff determination of the ohm (*vide* Report of the Committee on Electrical Standards, Appendices II. and III., 1894). They have been tested twice by Mr. Glazebrook and twice by the kindness of Major Cardew in the Board of Trade Electric Standardising Laboratory with the following results:—

Coil.	A. Mr. Glazebrook. Jan'y—March, 1894.	B. Board of Trade, November, 1896.	C. Board of Trade. August, 1897.
No.			
3,873	9·9919 at 14·8° C.	9·992994 at 14·86° C.	10·00712 at 19·3° C.
3,874	9·9926 at 14·9° C.	9·993213 at 14·91° C.	10·00775 at 19·3° C.
4,274	·100050 at 15·2° C.	·1000595 at 14·77° C.	·100078 at 19·4° C.
4,275	·100053 at 15·2° C.	·1000722 at 15·14° C.	·100081 at 19·4° C.

The coils Nos. 3,873 and 3,874 were stated by the makers—Messrs. Nalder—to be wound with platinum-silver wire, and the two others, Nos. 4,274 and 4,275, with manganin.

In the following are given the temperature coefficients as supplied originally by the makers, and as calculated from the tests A and C and B and C.

Temperature Coefficients of Resistance per 1° C.

Coil.	As supplied by Messrs. Nalder.	From tests A and C.	From tests B and C.
No.			
3,873	0·000276	0·000360	0·000318
3,874	0·000300	0·000344	0·000331
4,274	0·0000127	0·0000667	0·0000399
4,275	0·0000127	0·0000667	0·0000207

These figures show that a redetermination of the temperature coefficients which we are now carrying out is necessary.

Fortunately the last set of determinations of the resistance of these four coils was carried out at Westminster within a fortnight of the completion of our absolute measurements, and we are much indebted to Major Cardew for his kind promptness in the matter. The temperatures of these 1897 Board of Trade measurements were so nearly those of the coils during our final absolute determinations, which were from 18° 8 to 19°·4 C., as to render the effect of possible errors in the temperature coefficients negligible to the degree of accuracy aimed at by us. We have therefore used the August 1897 Board of Trade values for these coils, as transmitting the Board of Trade ohm to the laboratory in Exhibition Road.

The standard thermometers used in the investigation were sent to Kew, and their errors were determined at the time by the kindness of Dr. Cree: also thanks to Sir J. Norman Lockyer, the clock in the Mechanical Department of the Central Technical College, which transmitted seconds to the fast running Bain chronograph, was frequently timed by reference to the current sent hourly to his room from the General Post Office, and at 10 a.m. from Greenwich.

The results of successive measurements of the absolute resistances became very concordant after, little by little, various possible causes of small errors had been eliminated. Nine sets taken on July 30th, 1897, gave the following results for the value of the Board of Trade ohm in true ohms, without allowance being made for the error in the clock rate:—

	1·000286
	1·000256
	1·000285
	1·000351
	1·000295
	1·000277
	1·000306
	1·000284
	1·000307
Mean ...	1·000294

or, since the clock was found to lose during the daytime at the rate of 3 seconds per 24 hours, it follows that according to this investigation,

1 Board of Trade ohm = 1·00026 true ohms.

It is important to consider in which direction this result will be affected by sources of error that cannot be removed by careful adjustment, centreing, &c. They may be classified as follows:—

Source of error.	Effect produced.
1.—Over-estimation of the diameter of the coil arising, for example, from the stress on the copper wire having caused it to compress the under side of its silk covering.	Result would be too small.
2.—Under-estimation of the diameter of the phosphor bronze disc from a neglect of the tips of the circumferential brush tubes being possibly pushed away from the disc, by the stream of mercury issuing, &c.	Result would be too small.
3.—Presence of iron pipes, girders, &c., in the neighbourhood of the apparatus.	Result would be too small.
4.—Traces of iron in the phosphor bronze disc ...	Result would be slightly too small.
5.—Defective insulation between the support of the central brush and the supports of the circumferential brushes	Result would be too large.
6.—Defective insulation between the convolutions on the coil.	Result would be too large.
7.—Traces of iron in the marble ring	Result would be too large.
8.—Defective insulation of parts of the circuit from one another.	Effect would depend upon the position of the leaks.
9.—Permanent magnetic field at the apparatus ...	No effect, for the current through the field coil was periodically reversed.

As regards (4) and (7) special induction balances were constructed and used by Mr. Mather to test the permeability of both the marble ring and the phosphor bronze disc; but, although a deviation from unity of one part in fifteen thousand could have been detected in the permeability of either, no such deviation was observable.

* An account of this new formula, as well as of that for $\frac{d\,M}{M}$, will shortly be published by Prof. Viriamu Jones.

As regards (5) and (8) careful tests were made every day of the insulation resistance of the apparatus, and it was always found to be greater than 1,000 megohms.

6.—The insulation between the adjacent convolutions of wire could not be measured when they were silk covered and buried in paraffin wax, since a small leak between a pair of turns would not change the apparent resistance of the copper coil by as much as the variation in temperature of a fraction of 1°. We had, therefore, to content ourselves with the precautions, previously described, which were taken to secure high insulation in the winding of the coil.

When the ring was wound with bare wire it was possible to roughly compare the insulation resistance between pairs of convolutions by sending a constant current through the coil and measuring, very accurately, the P.D. between every adjacent pair of the 201 turns. This we did several times, but it was a long and laborious task.

When constructing a new Lorenz apparatus, it will be well to consider whether two separate helices should not be cut in the cylindrical surface of the marble ring in which two independent bare wires would be bound, a turn of the one being everywhere (except at the extreme ends) between two turns of the other. The insulation resistance, therefore, between the two windings would measure the insulation between the adjacent turns, while in the ordinary use of the apparatus the two windings would be joined in series, so as to constitute a single coil. In this way it may be possible to be more sure of the absence of (6) than by using paraffined double silk covered wire, and at the same time to entirely remove (1).

The direction of our experimental result, which shows that the Board of Trade ohm is between two and three parts in 10,000 larger than the true ohm could not, however, arise from (1). Nor could it from either (2) nor (3); still, many experiments were made to detect any evidence of the effective diameter of the disc being larger than its true diameter, as measured in the Whitworth machine. But no change in the pressure of the circumferential brush tubes nor alteration in the shape of their ends, &c., indicated that, with the brushes as we employed them, the effective diameter of the disc differed from its true diameter.

Our thanks are due to the three students whose names are given above for much assistance in carrying out the long series of observations, to Mr. Harrison for bringing to bear, from time to time, the experience that he had previously gained in the use of the Lorenz apparatus, and we are especially indebted to Mr. Mather for the suggestive aid which he rendered us throughout the whole of the present investigation.

SWITCH PANEL FOR TRAMWAY STATIONS.

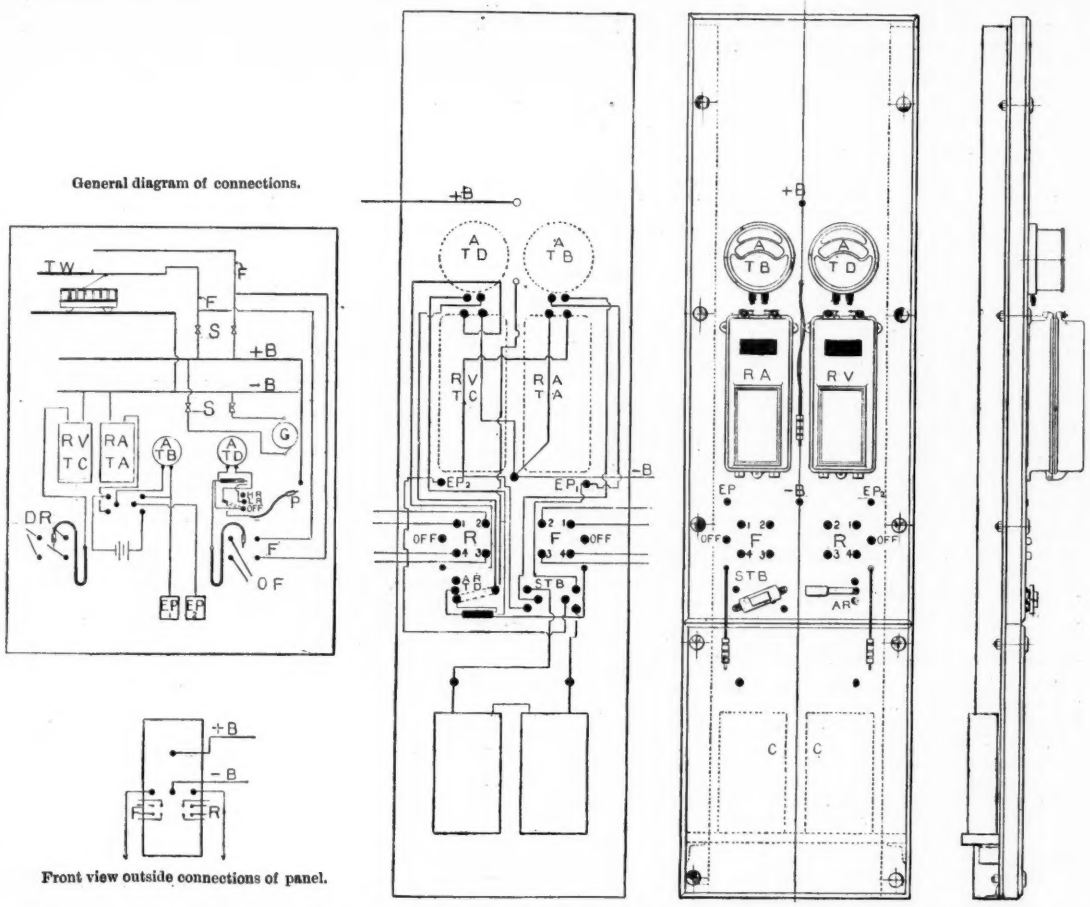
Messrs. Elliott Brothers are—as we intimated a fortnight ago—introducing a standard switch panel for Board of Trade tests in electric railway work. The regulations made by the Board of Trade for regulating the employment of insulated returns, or of uninsulated metallic returns of low resistance, for preventing fusion or injurious electrolytic action of, or on, gas or water pipes, or other metallic pipes, structures, or substances, and for minimising as far as is reasonably practicable injurious interference with the electric wires, lines and apparatus, or parties other than the company, and the currents therein, whether such lines do, or do not, use the earth as a return, require the following tests:—

A. Section 6 (1).—That the current passing from the earth connections through the indicator to the generator shall not at any time exceed either 2 amperes per mile of single tramway line, or 5 per cent. of the total current output of the station.

B. Section 5.—The earth connections referred to in this regulation shall be constructed, led, and maintained, so as to secure electrical contact with the general mass of earth, so that an electromotive force, not exceeding 4 volts, shall suffice to produce a current of at least 2 amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with.

C. Section 7.—When the return is partly or entirely uninsulated, a continuous record shall be kept by the company of the difference of potential during the working of the tramway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limit of 7 volts, the company shall take immediate steps to reduce it below that limit.

D. Section 10.—The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed $\frac{1}{100}$th of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running, when the line is fully charged. If at any time it should be found that the leakage current exceeds $\frac{1}{2}$ of an ampere per mile of tramway, the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours; provided that where both line and return are placed within a conduit this regulation shall not apply.



B, Bus bars; F, Feeders; S, Switches; T W, Trolley wire; G, Generator; R V T C, Recording voltmeter test C; R A T A, Recording ammeter test A; A T B, Ammeter test B; A T D, Ammeter test D; D B, To distant rail points; H R, High range; L R, Low range; P, Plug; O F, Other feeders; R, Rail points; A R T D, Ammeter ranges, Test D; S T B Switch, Test B R A, Recording ammeter; R V, Recording voltmeter; A R, Ammeter ranges; C C, Cells to give 4 volts.

E. Section 11.—The insulation resistance of all continuously-insulated cables used for lines, or insulated returns for feeders, or for other purposes, and laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation resistance of all such cables shall be made at least once in each month.

F. Section 6 (2).—That if at any time, and at any place, a test be made by connecting a galvanometer or other current indicator to the uninsulated return, and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe; or by interposing one Leclanché cell, if the direction of the current is from the pipe to the return.

Daily Records Required.

Maximum current from the earth connections, *see* Regulation 6 (1).
Leakage current, *see* Regulation 10.
Fall of potential in return, *see* Regulation 7.
Maximum working current, *see* Working Pressure.

Monthly Records.

Conductance of joints to pipes, *see* Regulation 8.

Occasional Records.

Any test made under provisions of Regulation 6 (2). Localisation and removal of leakage, stating time occupied.

Particulars of any abnormal occurrence affecting the electric working of the tramway.

The following is the suggested arrangement of instruments to carry out the above requirements.

A. Section 6 (1).—Recording ammeter to read 5 per cent. of the total output, or 2 amperes per mile of tram. Range of instrument 0 to 10 amperes connected between the earth plates and the negative bus bar in the station, for total leakage test. This instrument can be arranged with the zero in the centre of the scale, so that the polarity or direction of the current, as well as the amount of it can be recorded on one instrument, if necessary, in any case.

Note.—In recent practice it is found that much less than 2 amperes per mile of tram has to be dealt with, and the range of the instrument is chosen in accordance with such experience.

B. Section 5.—An indicating ammeter to read from 0 to 10 amperes. This instrument would be placed in series with two accumulator cells, or three large Leclanché cells, and the two earth plates, so as to indicate the current passing between the earth plates with an electromotive force of 4 volts, and therefore the resistance between them.

C. Section 7.—Recording voltmeter connected between the negative bus bar in the station and the point of maximum drop on the rail, to show the fall of potential on the rail, range suggested 0 to 10 volts. It is suggested that a multiple single pole switch shall be used in connection with this instrument to record from any one point at will.

D. Section 10.—Ammeter for indicating the leakage from the line when no cars are running, preferably made with two ranges, one reading up to ·05 ampere, so that ·0005 ampere can be read, and the other range reading up to 5 amperes, so that ·05 ampere can be read. A multiple switch can be used to join up any desired feeder, so that its insulation may be observed if its distant end is disconnected, and there is a special device arranged to protect the point joined to the positive bus bar, so that there is only one insulated stud connected to the 500 volt circuit under ordinary running conditions, all the instruments and switches being practically at each potential; this device tends to minimise any chance of connecting the test ammeter in circuit when cars are running.

E. Section 11.—Set of instruments for general insulation testing. These are quite apart from the circuit, and therefore can be in the form of a test table, some portable testing set, or the insulation and bridge test panel now made by us for such station work, on which a complete set of test instruments is mounted in convenient form. (Standard set No. 418.)

F. Section 6 (2).—Galvanometer and Leclanché cells for testing current, and electromotive force at which it flows from the return to any pipe, or *vice versâ*. A detector galvanometer can be used in a small case with three Leclanché cells, with connections arranged so that either one or all three can be placed in series with the galvanometer.

Note.—Weston ammeters are used in all cases, and the recording instruments are arranged for continuous paper slip.

Messrs. Elliott are introducing what they term the Standard Board of Trade panel, Type E. P. For use in stations where earth plates are put down. The panel is made of white marble or slate 62 × 24 × 2 in. thick, mounted over a lower panel of white marble or slate 28 × 24 × 2 in. thick, the total height being 7 ft. 6 in.; these sizes are taken to coincide with the American standard railway switch panels. The two marble or slate pieces are secured to upright angle irons 3 × 3 × ½ inch by means of 12 bolts, six on each side, and wrought-iron angle brackets are bolted to the ends of these angle irons for attachment to the framing used to carry other panels of the switchboard.

Upon these panels are mounted at a convenient height:—Multiple switch for the connection of any feeder to the low reading ammeter used in Test D. Multiple switch for connecting either of several wires led from distant points along the rail to the recording voltmeter used in Test C. Recording ammeter used for Test A. Recording voltmeter used for Test C. Indicating ammeter with switch for range from 0 to 10 amperes used in Test B. Indicating ammeter double range ·0005 to 5 amperes for Test D. Switch for joining up the indicating ammeter to the earth plates, &c., for test B. Switch for altering range of ammeter for Test D. Insulated plug on flexible cord for connecting up ammeter for Test D to positive bus bar terminal, an ebonite shutter protecting this terminal under running conditions.

Behind the lower panel are placed, on a small shelf, two small accumulator cells, or three large Leclanché cells for the supply of 4 volts required for Test B. Terminals are provided for attachment of the wires leading to the feeders, the positive and negative bus bars, the rail points and the earth plates, consisting of copper studs screwed ⅜ Whitworth thread, and provided with washers, nuts and thimbles for soldering the connection cables into. A space is left at the top of the panel, in this arrangement, sufficient for two more recording instruments, either ammeters or voltmeters. The whole arrangement is complete in itself, and can be placed in any convenient position in the generating station.

Messrs. Elliott are also introducing Type W panel for use in stations where the negative bus bar is joined to the water main system, in the manner recommended by the Board of Trade. In this case Test B is not necessary. The panels are made of exactly the same form as in Type E. P. The instruments are mounted in the same way, and are as follows:—Multiple switch for the connection of any feeder to the low reading ammeter used for Test D. Multiple switch for connecting either of several wires led from distant points along the rail to the recording voltmeter used in Test C. Recording ammeter used for Test A. Recording voltmeter used for Test C. Indicating ammeter range from ·0005 to 5 amperes used in Test D. Switch for altering range of ammeter for Test D. Insulated plug device as in panel E. P. The lower panel in this case is left blank. Terminals are provided for attachment of the wires leading to the feeders, the positive and negative bus bars, and the rail points, consisting of copper studs screwed ⅜ Whitworth thread, and provided with washers, nuts and thimbles for soldering the connection cables into. A space is left at the top of the panel in this arrangement sufficient for two more recording instruments, either ammeters or voltmeters.

Our illustrations show the panel arrangements as well as the connections necessary for carrying out the tests.

MECHANICAL FEATURES OF ELECTRIC TRACTION.*

By PHILIP DAWSON.

Introductory.—Previous to discussing certain special mechanical features which enter into the design and construction of an electric traction system, a few figures may be quoted for showing the importance of the subject in general.

Table 1 shows the mileage of tramways in America for the six years 1890—5. It is seen that rope traction continued to extend up to 1894; since that time its importance has diminished. In San Francisco, Los Angeles, Minneapolis, Denver, St. Louis, Pittsburgh, Philadelphia, Baltimore, and other American cities, electric traction has been substituted in place of ropes.

Table 2 gives the electric tramway mileage in Europe at the end of last year, 1896. It will be seen that Great Britain is yet much behind Germany. This is especially remarkable, because the regulations of German local authorities are generally much the more severe. Electric trolley roads are now to be found in the oldest and handsomest of German cities.

Table 3 shows the great financial importance of tramways as compared with railways in America. The passenger traffic on the tramways is six times greater than that on the railways; and the ratio of working expenses to receipts is lower for the tramways than for the railways. The gross earnings of the tramways in the United States are approximately 50 per cent. of the passenger earnings of the railways, and 15 per cent. of the total earnings of the railways,

Table 1.—Mileage of Tramways in America, and number of Cars, during six years, 1890—95.

Mileage.	1890.	1891.	1892.	1893.	1894.	1895.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
Electric	2,523	4,061	5,939	7,466	9,008	12,583
Horse	5,400	5,302	4,460	3,497	2,243	1,232
Rope	510	594	646	657	662	599
Steam	604	642	620	566	614	519
Total miles ...	9,037	10,599	11,665	12,186	12,527	14,933
Number of cars.	Cars.	Cars.	Cars.	Cars.	Cars.	Cars.
Electric	5,592	8,692	13,415	18,233	24,849	36,121
Horse	21,970	21,798	19,315	16,845	11,507	5,420
Rope	3,795	4,372	3,971	4,805	4,673	4,871
Steam	751	815	698	616	639	2,957
Total cars ...	32,108	35,877	37,399	40,499	41,668	49,369

* Read before the Institution of Mechanical Engineers, November 4th.

TABLE II.—MILEAGE OF ELECTRIC TRAMWAYS IN EUROPE, AND NUMBER OF CARS, AND HORSE-POWER, AT END OF 1896.

Country.	Miles of tramway.	Number of cars.	Horse-power.
Germany	618	1,545	13,810
France	67	180	4,200
Great Britain and Colonies ...	167	269	9,617
Austria and Hungary	120	265	5,060
Italy	50	149	2,460
Switzerland	30	83	1,570
Belgium	90	157	2,550
Russia	30	87	1,150
Other countries	30	50	111

TABLE III.—COMPARISON OF RAILWAYS AND TRAMWAYS IN AMERICA AND IN ENGLAND.

	Railways R. Tramways T.	Capital expenditure. £	Total mileage.	Gross receipts. G £	Total expenses. E £	Ratio E to G per cent.	Passengers carried.
America.	R.	2,354,200,000	240,000	219,000,000	154,000,00	70	544,000,000
	T.	280,000,000	14,000	32,850,000	22,700,000	68	3,000,000,000
United Kingdom.	R	880,000,000	20,000	77,025,000	40,100,000	52	775,200,000
	T.	13,000,000	1,000	3,540,000	2,640,000	75	480,000,000

TABLE IV.—COST OF TRAMWAYS IN SMALL AND LARGE TOWNS IN MASSACHUSETTS.

Per mile of single line.	Springfield.	West End.
Construction and equipment	£4,939	£11,323
Other permanent property	£1,761	£7,959
Total cost	£6,701	£19,282
Capital investment	£6,197	£20,152
Passengers carried, total	10,163,011	166,862,288
" " per mile	180,547	648,568

TABLE V.—PASSENGERS CARRIED ON TRAMWAYS AND ON RAILWAYS.

	1895.	1896.
Worked by horses only ... ... miles	61·799	35·132
" " electricity only ... ... miles	1,002·756	1,241·363
" " horses and electricity ... miles	22·62	14·54
Total income ... ... £	2,649,274	2,980,188
Dividend ... ... per cent.	5·6	5·87
Passengers carried, total	259,794,308	292,358,943
" " by electricity	205,866,134	236,544,417
" " by railway	53,928,174	55,814,525
" " excess by electricity ...	151,937,960	180,729,892

whereas the tramway mileage is only about 6 per cent. of the railway mileage. A highly important fact is that tramway receipts are found to be practically independent of good or bad trade, and not to depend on the prosperity of the country.

Tables 4, 5 and 6 have been compiled from the official reports of the Massachusetts Board of Railroad Commissioners. Massachusetts more closely resembles England in the habits of the people, and in local conditions, than any other State of the Union. Table 6 shows the rapid increase of passenger traffic and mileage. Table 4 shows the difference in cost of completely equipping tramways in small and large towns, varying from £7,000 to £20,000 per mile of single line. Table 5 shows that, as passenger carriers, tramways play a much more important part than railways. It is demonstrated, not only in America, but also in England and on the Continent, that wherever an electric tramway runs parallel to a railway, the former will secure practically all local traffic. It has been frequently urged that mechanical motive power on tramways is dangerous to the public safety. In America, where comparatively high speeds are allowed, the Railroad Commissioners report that the proportion of passengers and employés killed during the last two years of electric working appears to have been about the same as with the use of horse-power in 1888.

For all practical purposes the present subject may be considered under the three headings of outside work, rolling stock, and power station.

Outside Work.—Wires.—The overhead line of conductors may be supported either by brackets attached to poles or to houses, or by a span-wire stretched between poles or rosettes fixed to house fronts. For the sake both of appearances and of smooth running, the conducting wire should be strained as tight as is consistent with its tensile strength, and with the minimum temperature which obtains in the locality. The best practice does not allow more than 2,000 lbs. strain on a No. 0 Brown & Sharpe (0·325 inch diameter) hard-drawn copper wire at the lowest temperature to which it will be exposed. With this limit the strain to be put on the wire when erected can be easily ascertained from tables. For fixing the maximum

TABLE VI.—GROWTH OF MASSACHUSETTS TRAMWAYS DURING 10 YEARS, 1887—96.

Year.	No. of Cos.	Miles of main line.	Miles equipped for horses.	Miles equipped for electricity	Cost of construction.	Cost of equipment.	Capital investment.
1887	44	470·27	470·27	...	£3,524	£1,666	£6,534
1888	46	533·59	533·99	...	3,384	1,464	6,461
1889	46	574·17	523·65	50·52	3,236	1,576	6,781
1890	48	612·38	451·52	160·86	3,467	2,131	7,651
1891	56	672·45	383·42	289·03	3,584	2,323	8,178
1892	61	754·85	258·55	496·30	3,904	3·043	9·2·0
1893	60	874·14	163·06	711·08	5,355	2,347	10·673
1894	68	938·84	103·87	824·97	5,349	2,305	10,592
1895	75	1,077·99	61·20	1,016·19	4,797	2,096	9,820
1896	83	1,276·75	25·13	1,241·62	4,679	1,961	9,278

Year.	Passengers carried.	Car miles run.	Persons employed.	Cars.	Horses.	Motors.
1887	124,787,329	20,625,846	5,222	2,633	11,874	...
1888	134,478,319	23,243,767	5,531	2,588	11,391	...
1889	148,189,403	24,259,491	6,202	2,942	11,817	...
1890	164,873,846	26,516,937	6,246	3,247	11,241	...
1891	176,090,189	27,670,166	6,449	3,494	10,640	...
1892	194,171,942	29,678,036	7,185	3,679	6,734	...
1893	213,552,009	34,507,282	8,070	4,040	3,531	3,013
1894	220,464,099	36,722,978	7,451	4,058	2,014	3,906
1895	259,794,308	43,655,560	8,048	4,426	1,436	4,704
1896	292,358,943	53,613,685	9,130	4,913	878	5,958

sag to be allowed in the average span of 120 to 140 feet, a rough but safe rule in this country, where rarely more than 20° Fahr. of frost is to be expected, is a sag of 0·75 per cent. of the span, at an average temperature of from 60° to 65°. The trolley wire should be of absolutely even quality, and supplied in lengths of slightly over half a mile. The joints should be silver-brazed in the copper ingot before it is rolled. The diameter of the wire should not be allowed to vary more than 0·0004 inch. The breaking strain of the wire should be at the rate of 56,000 lbs., or 25 tons per square inch. In span-wire construction it is necessary to determine both the height of the eye-bolts from which the span-wire is suspended, and also the sag. In Table 7 are given data of galvanised steel span-wires generally used.

TABLE VII.—GALVANISED STEEL SPAN-WIRES.

Thickness of wire {	wire-gauge No.	15	12	11	10
	inch	0·070	0·110	0·120	0·135
Number of strands		7	7	7	7
Total approximate diameter	inch	1-4th	5-16ths	3-8ths	7-16ths
Weight per hundred feet run	lbs.	10	21	29	36
Tensile strength absolute	lbs.	1,600	3,360	4,640	5,720

TABLE VIII.—STANDARD TUBULAR POLES.

Total length of pole.	Length and outside diameter of three component pipes.						Total weight.	Free from permanent set at
Feet.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Lbs.	Lbs.
29	16½	× 10	8	× 8	7½	× 7	1,503	4,500
30	17	× 10	8½	× 8	7½	× 7	1,552	4 400
31	17	× 10	9½	× 8	7½	× 7	1,593	4,200
28½	16	× 8	8	× 7	7¼	× 6	1,193	3,400
29½	16	× 8	9	× 7	7¼	× 6	1,224	3,200
30	17	× 8	8½	× 7	7¼	× 6	1,259	3,150
28½	16	× 7	8	× 6	7¼	× 5	769	2,000
29½	16	× 7	9	× 6	7¼	× 5	991	2,000
30	17	× 7	8½	× 6	7¼	× 5	998	1,800
28½	16	× 6	8	× 5	7¼	× 4	689	1,200
29½	16	× 6	9	× 5	7¼	× 4	613	1,000

Poles.—Upon the amount of sag allowed for the span-wires depends the strain which the side poles must stand. Round curves these strains are often great, and tubular poles composed of ordinary pipes wedged together by liners are useless. In Table 8 are given

certain data of standard poles specially designed for this work. All poles must be of such strength that when in position they will stand without permanent set the greatest side strains to which they may be subjected. Terminal poles and pull-off poles on curves should be the strongest. Ordinary side poles must stand a direct strain of at least 500 lbs., without deflecting more than 4 to 6 inches. Their strength must be sufficient to carry, besides the trolley wire itself, the additional weight when the wires are covered with ice and snow. The poles are always subject to vibration communicated from the trolley wire. It is of the utmost importance that joints should be well constructed, which renders it necessary that the several lengths of the pole should be sweated together. The joint is made by heating the outside pipe to a welded heat, slipping it over the inner pipe, and then passing the two together through special rollers. After completion, if a piece is cut from the joint between A and B, the two pipes will be found solidly welded together, the joining line A B having entirely disappeared. This is known as the "S S S" joint, the abbreviation meaning solid, swaged, and sweated. The tubes used in making poles are all lap-welded, and the larger sizes are also riveted along the seam with counter-sunk rivets. The lengths of pipes are so put together that the seams of each consecutive length are 120° apart, when the poles are made in three lengths, as is generally the case. If joints are not so made, the pole, instead of bending uniformly, after a short time gives at the joints. Poles constructed with S S S joints can be accurately calculated to stand any determined strain without exceeding a fixed temporary and permanent deflection. This is not possible with other joints, which always give trouble sooner or later.

For the standard poles used at Bristol and Dublin five sizes are required, all 31 feet long, and set in the ground to a depth of 6 feet. No. 1 has to stand a lateral strain of 350 lbs. applied at top, with maximum temporary deflection of 6 inches; and a strain of 700 lbs. with maximum permanent deflection of ½ inch. For the four others the corresponding limits are:—

No. 1	...	350 lbs.	with	6 inches,	and	700 lbs	with ½ inch.
No. 2	...	500	"	"	"	1,000	" "
No. 3	...	700	"	"	"	1,200	" "
No. 4	...	1000,	"	"	"	1,700	" "
No. 5	...	2,000	"	"	"	2,600	" "

The poles are required to be as nearly round as possible. A difference of ¼th inch between maximum and minimum diameter is all that is allowed. In order that they may all be as nearly uniform as possible, $\frac{1}{16}$th inch more or less than the prescribed dimensions is all that is allowed. The greatest distance out of the true that is allowed at the top of the pole is ¼th inch. Ten per cent. of each lot of poles are tested; should three poles fail to come up to the requirements, the right is reserved to reject the entire lot. The poles are dropped three times, butt foremost, from a height of 6 feet upon some solid substance; after which they must show no signs of telescoping or loosening in the joints.

Insulators.—Insulators must be mechanically strong, and the insulation protected by a metallic covering from external injury. Special insulators have been designed for every variety of service, samples of which are exhibited. For ordinary tramway service the wire is usually soldered into the gunmetal ears of the insulators; but the heavy "figure 8" wire, used for light railways and high speed lines, is supported by mechanical clips. Occasionally an extra heavy round wire is used, which is then milled out by a portable tool at the points of support, in order to afford a proper grip for the mechanical ears.

Rolling Stock.—This can be subdivided into car bodies, trucks, motors, and their accessories. The bodies possess no special features, except that all framing must be extra strong.

Trucks.—The supply of suitable trucks for both motor and trailer cars is of the utmost importance. The introduction of electric traction has revolutionised the construction of running gear. In former days, when horses and mules were the only motive power for street cars, it was considered quite sufficient to support the car body upon a single set of springs carried by the boxes, a simple bar being often the only connection between the two sets of wheels. The adoption of the electric power and of cars equipped with single or double motors added immensely to the weight carried by the axles, and rendered it necessary to adopt efficient methods for cushioning and suspending the motors over the axles, while maintaining a rigid connection between motor and axle. At first the motors were rigidly attached to the bottom of the floor of the car body. This construction did not prove a success, for both car floor and motor deteriorated rapidly, and access to the motors was also difficult.

Experience demonstrated that the only effective plan was to attach the motors to an independent truck frame, and to have all the mechanism of the car entirely independent of the car body. For this purpose an independent truck was introduced, consisting of pedestals secured by centre bars; upon the pedestals the motors were suspended by cross-bars connecting the side frames of the truck together. While these trucks supported the motors independently of the car body, they did not properly support the car body itself, which had increased in length and width. The increased length and width of the electric car, together with the increased speed at which it ran, rendered a stronger and longer truck necessary. At first the old street car pedestals were fastened to a separate pair of sills. The axle boxes still played up and down in these pedestals to the full extent of the motion of the car body. This device proved insufficient. The next step in advance was to secure the pedestals carrying the axle boxes to side frames, which carried the springs supporting the car body. This construction, however, allowed excessive swaying of the car body, owing to the fact of the connection between the wheels and the body not being sufficiently rigid. Moreover, no provision had been made for easily removing the wheels, which required the truck to be practically taken to pieces. The brakes were hung to the upper chord of the truck, the effect of which was that, when the springs were compressed, the brake shoes dropped lower on the wheels, changing the distance between the shoe and the wheel.

The introduction of mechanical motors, occupying so little room that a capacity of 50 or 60 horse-power can readily be placed in the space allowed by the truck, has led to a large increase in the weight of the car body, and a consequent lengthening of the wheel-base. The modern electric car bodies carried on four wheels are seldom shorter than 18 feet over the end panels, and sometimes reach 22 feet length, exclusive of the platforms, while the whole length of the car over the platforms is from 30 to 32 feet. This increase of nearly 25 per cent. in the length, and more than 25 per cent. in the weight of the bodies, has been accompanied by an increase of only about 20 per cent. in the wheel-base of the trucks. As a result, a long and rigid spring-base is an absolute necessity for a modern electric truck. Without this, the whole stress of carrying both the dead weight of the car and platforms, and the fluctuating weight of the load, would fall on the car sills and body, and the motion of the car would continually wrench and strain its framing. In the conditions met with in street service the wheel-base cannot be lengthened much over 7 or 7½ feet; and on this account a long spring-base must serve the purpose of an increased wheel-base for the long cars now employed. To obtain easy riding it is necessary that all the springs should be sufficiently light to obviate vertical motion in the car body; consequently these light springs, in order to prevent excessive motion of the ends of the car, must be carried out just as far apart as it would be necessary to carry the wheels if the old horse-car arrangement were adopted for the modern long-car bodies.

To secure the necessary rigidity of the long side-frames, and at the same time keep their weight within reasonable limits, different plans have been adopted. In earlier designs it was attempted to overcome the difficulty by casting the pedestals and overhang in one piece, and lengthening the joint between these castings and the bars. Another method consisted in trussing the overhang with straining rods running over the tops of the pedestals, and provided with turn-buckles for taking up the strain as the overhang worked down, but turn-buckles slack off, and the bolted joints wear loose, and a continual wear and rattle was the result. Some makers constructed the side frames of the truck in one piece, by bolting heavy centre-bars to the pedestals. Others, again, forged the side frame of the truck, and welded the whole together into one piece. But these designs have not proved sufficiently strong to support properly the permanent pressure upon the ends of the overhang, when the overhang is carried out to the length of the modern car-body.

The demand for this special class of work brought out a host of devices, of which ten years' experience have sifted the useful from the useless; and it may be fairly stated that the chief principles involved in the design of a thoroughly good motor-truck, fulfilling all or most of the conditions imposed by electric traction, have now been fully recognised, with the result that the electric motor-truck has been matured to a standard form. Truck building has become an independent business in America, although many car works still make some form of truck for themselves. Rigid frames had been employed in trucks for cars driven by gas, steam, compressed air, or cable grip; but in all of these the conditions are entirely different from those in electric motor cars. This experience was dearly bought by some of the earlier electric tramways, as was testified by many a scrap heap composed of trucks which, after running but a few miles, had to be discarded.

The quality of the motor trucks may mean the success or failure of an electric tramway; and to secure a good truck is quite as indispensable as to use a well constructed and efficient motor. A motor truck comprises many parts, the most important of which are the side frames, springs, wheels, axles, boxes, bearings, motor bearings and suspension, sand boxes, brakes, and safety appliances. The following are the essential conditions which must be fulfilled by a truck in order that it may be suitable for electric traction:—

1. The truck must be as light as possible, consistently with rigidity and strength.

2. It must be thoroughly braced, so as to keep it stiff and square without having to depend in any way on the car body. The strains on a motor car in rounding curves and when passing a change of gradient are extremely severe: much more so than with horse-cars, where the horses pull the car round on curves, and go slower at a change of gradient.

3. The journal-boxes must be self-lubricating, must require but little attention, and must be dust-proof.

4. The brake action must be simple, effective, and easily adjustable; and the brake shoes must admit of being replaced at a moment's notice, and must be mounted in such a way as not to be influenced by the vertical motion of the car.

5. The truck must be constructed in such a manner as to render access easy to all parts; and to admit of motors, wheels, and axles, journal-boxes, brake-gear, and other parts being easily removed without having to dismember the truck. Cross strains on bolts should be avoided as much as possible.

6. The car body must be attached to the truck in such a manner as to be readily removed on loosening a few bolts.

7. Springs must be arranged so as to render the running of the car as smooth when empty as when fully loaded, and to prevent the pitching and rolling motion to which street cars are so liable on sharp curves and rough roads. This is a highly important point, not only for the comfort of the passengers, but also to prevent rapid deterioration of the car wiring and car bodies; deterioration of the wiring is likely to cause grave results to the motors by producing short circuits.

8. An appropriate choice of wheels is most important.

There are three different kinds of trucks: the rigid four-wheel, the radial six-wheel, and the four-wheel bogie for eight-wheel cars. Of these three, however, only the first and third are generally used, the radial truck not having given the satisfactory results which were expected.

Four-wheel Truck.—In the rigid four-wheel truck, where the wheel-base is naturally restricted, it is of the greatest importance to have an arrangement whereby the car body is supported as far outside the wheel-base as possible; and to diminish as much as may be, by the judicious use of springs, the destructive effect of jolting, both upon the car body and upon the motor equipment. The best modern truck, which has been employed on all the latest and best equipped British and colonial tramways, is the "Peckham," of which models are exhibited. It has been adopted by Bristol, Dublin, Guernsey, Clontarf, Coventry, Isle of Man, North Staffordshire, Dover, Leeds, Birmingham, Brisbane, Sydney, and other places; and in all cases has given the utmost satisfaction. The support selected as the model for a truck frame is the standard cantilever bridge-truss, which experience in bridge building has shown to be the strongest form of construction. This truss principle has been closely followed in the construction of the Peckham truck; and while various modifications in detail have been made to adapt trucks to the various conditions occurring in street tramway practice, the characteristic bridge form of truss has been strictly adhered to in all of them. The cantilever truck has now come to be regarded as the standard for the best work in the United States, inasmuch as 15,000 are now in use in that country.

(*To be continued.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

25,299. "Improvements in electrical rain gauges." A. J. V. Rapkin, R. H. D. Rapkin and A. D. Wilson. Dated November 1st.

25,302. "Improvements in electrical conductors." W. Judd. Dated November 1st.

25,307. "Improvements in or connected with drum armatures for dynamo-electric generators and motors." V. A. Fynn. Dated November 1st. (*Complete.*)

25,335. "Improvements in electric stop motions for drawing frames used in the preparation of cotton and other fibres for spinning." M. T. Makin, J. Lee and S. Knott. Dated November 1st.

25,364. "Improvements in electric switches." V. G. Liboni. Dated November 2nd.

25,369. "Improvements in electromagnetic circuit breakers." W. G. Heys. (Daniel C. Spruance and Montgomery Waddell, United States.) Dated November 2nd. (*Complete.*)

25,386. "Improvements in chemical electric generators." H. K. Hess. Dated November 2nd. (*Complete.*)

25,388. "Improved compositions for use in the construction of electric heating apparatus and resistances and the processes for their manufacture." L. Parvillee. Dated November 2nd. (*Complete.*)

25,400. "Improved electrolytic process and apparatus for the separation of metal from their ores and solutions." E. Motz and H. F. Welch. Dated November 2nd. (*Complete.*)

25,403. "Improvements in or relating to current collectors for electric railways." A. J. Boult. (Frederick Augustus Anderson and David Marsden Anderson, United States.) Dated November 2nd.

25,412. "Improvements in electrical resistances." T. E. Gambrell and A. F. Harris. Dated November 2nd.

25,420. "Method and apparatus for saturating, vulcanising, and oxidising fibrous materials in the production of material to be used for insulating and other purposes." F. Lamplough. Dated November 2nd.

25,434. "Improvements in trolley wire hangers for use in overhead lines of electrical railways or tramways." P. Dawson. Dated November 2nd.

25,437. "Process and arrangement for intensifying telephonic reproduction." G. Cohn. Dated November 2nd.

25,441. "Improvements in electric accumulators." H. H. Lake. (Gaston de Digoine, France.) Dated November 2nd.

25,446. "Improvements in apparatus for electrical controlling engines, electromotors, and other machinery." W. H. Harfield. Dated November 2nd.

25,454. "Improvements in dynamo-electrical machines." F. Caire. Dated November 2nd.

25,480. "Improvements in electric accumulators." A. Graemiger. Dated November 3rd.

25,519. "Improvements in electrodes." J. Hargreaves. Dated November 3rd.

25,528. "Improved valve apparatus for electric batteries. W. H. Akester. Dated November 3rd. (*Complete.*)

25,537. "Improved electrical appliance or lamp for dental and other purposes." A. M. Stansfield. Dated November 3rd.

25,563. "A new or improved adjustable cord reel for electric pendant cords and other similar purposes." W. H. Sturge. Dated November 4th

25,581. "A lighting regulator for gas and petroleum motors." H. Crouan. Dated November 4th.

25,582. "Electric lighter for gas and petroleum motors." H. Crouan. Dated November 4th.

25,594. "Improved high voltage ceiling rose and special adjustment pulley ring for balance weight with special constructed terminals." J. E. Bunce. Dated November 4th.

25,599. "Improvements in electricity meters." Chamberlain and Hookham, Limited, and S. H. Holden. Dated November 4th.

25,646. "An improvement in the manufacture of bulbs for electric glow lamps." F. W. Dunlap. Dated November 4th.

25,647. "An improvement in the manufacture of globes and shades for electric and other lamps." F. W. Dunlap. Dated November 4th.

25,650. "Improvements in armatures for dynamo-electric machinery." J. S. Lewis. Dated November 4th.

25,653. "Improvements in or applicable to incandescent electric lamps." S. Biheller. Dated November 4th.

25,659. "Improved manufacture of electrical vacuum tubes." F. H. Glew. Dated November 4th.

25,674. "Generation of electricity at gas works by utilising waste gases." S. T. White. Dated November 5th.

25,703. "Improvements in electrical batteries." W. W. Hanscon and A. Hough. Dated November 5th. (*Complete.*)

25,713. "Improvements in closed conduit systems of electric traction." A. B. Loach. Dated November 5th.

25,723. "Improvements in alternating electric current meters." G. A. Scheeffer. Dated November 4th. (*Complete.*)

25,744. "Improvements in alternate current induction motors." The British Thomson-Houston Company, Limited, and H. M. Hobart. Dated November 5th. (*Complete.*)

25,745. "Improvements in reactance coils." The British Thomson-Houston Company, Limited, and H. M. Hobart. Dated November 5th. (*Complete.*)

25,755. "Automatic electric signal device for preventing railway accidents." B. G. Sabat, J. Drohomirecki and A. Rosenberger. Dated November 5th.

25,757. "Improved manufacture of electrodes for electrical accumulator or secondary batteries. O. Imray. (La Société Anonyme pour le Travail Electrique des Metaux, France.) Dated November 5th.

25,771. "An electric fire alarm." J. Higgins. Dated November 6th.

25,805. "Improvements in and relating to overhead conductors for electrically propelled tramcars and the like." J. T. Wood and J. A. Bodie. Dated November 6th.

25,811. "Improvements in fusible sockets for electric lamps." S. H. Russell. Dated November 6th. (*Complete.*)

25,816. "Improvements in insulators." D. Sinclair and W. Aitken. Dated November 6th.

25,818. "Improvements in electric bells." J. Mackenzie. Dated November 6th.

25,830. "Improvements in or connected with electric burglar alarms also applicable as a door or house bell." W. Menze. Dated November 6th.

25,832. "Improvements in dynamo electro-magnets and the like and in wire or winding for the same and for other electric purposes." C. F. Blundell. Dated November 6th.

25,869. "An improved system for the distribution of electric currents and apparatus therefor." G. Moller. Dated November 6th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

9,964. "Improved electric cables." G. H. Nisbett. Dated May 11th, 1896. Relates to cables as compound conductors, which are formed of groups of solid or stranded conductors arranged in segmental form and separated by a sepia of insulating material. The insulation is carried round the conductors, and the whole is enclosed in an armouring or sheathing. The groups may be formed of conductors of varying size or of all the same size. The shape of the group may be obtained by rolling, and a twist may be given to the conductors whilst forming the cable.

9,975. "Improvements in and relating to conduits for electric conductors." F. Bathurst. Dated May 11th, 1896. Conduits are formed of an insulating tube round which is formed a tube or sheathing of zinc or other metal or alloy. The sheath is burnished or planished. Junction sheaths, elbows, and T's are formed of short lengths of double metal tube having bushings of insulating material.

10,718. "Improvements in the manufacture of positive lead electrodes for electrical accumulators." H. O. Tudor. Dated May 18th, 1896. Plates or electrodes are manufactured by charging lead plates, which may have a thin coating of lead oxides or salts thereon as positive electrodes in very weak sulphuric acid, for the purpose of forming a layer of lead oxide containing sulphate. The charging at this is intermittent. The plates are then reduced in the same solution by charging them as negative electrodes, and these are finally reconverted into positive electrodes by continually charging and discharging them in stronger acid than that previously employed.